BUILDING ENERGY RESEARCH

HEARING

BEFORE THE

SUBCOMMITTEE ON
ENERGY DEVELOPMENT AND APPLICATIONS

OF THE

COMMITTEE ON
SCIENCE AND TECHNOLOGY
U.S. HOUSE OF REPRESENTATIVES

NINETY-SEVENTH CONGRESS

SECOND SESSION

JULY 22, 1982

[No. 139]

Printed for the use of the
Committee on Science and Technology

U.S. GOVERNMENT PRINTING OFFICE

11-221 O WASHINGTON : 1982

H701-19

COMMITTEE ON SCIENCE AND TECHNOLOGY

DON FUQUA, Florida, *Chairman*

ROBERT A. ROE, New Jersey
GEORGE E. BROWN, JR., California
JAMES H. SCHEUER, New York
RICHARD L. OTTINGER, New York
TOM HARKIN, Iowa
MARILYN LLOYD BOUQUARD, Tennessee
JAMES J. BLANCHARD, Michigan
TIMOTHY E. WIRTH, Colorado*
DOUG WALGREN, Pennsylvania
RONNIE G. FLIPPO, Alabama
DAN GLICKMAN, Kansas
ALBERT GORE, JR., Tennessee
ROBERT A. YOUNG, Missouri
RICHARD C. WHITE, Texas
HAROLD L. VOLKMER, Missouri
HOWARD WOLPE, Michigan
BILL NELSON, Florida
STANLEY N. LUNDINE, New York
ALLEN E. ERTEL, Pennsylvania
BOB SHAMANSKY, Ohio
RALPH M. HALL, Texas
DAVE McCURDY, Oklahoma
MERVYN M. DYMALLY, California

LARRY WINN, JR., Kansas
BARRY M. GOLDWATER, JR., California
HAMILTON FISH, JR., New York
MANUEL LUJAN, New Mexico
HAROLD C. HOLLENBECK, New Jersey
ROBERT S. WALKER, Pennsylvania
EDWIN B. FORSYTHE, New Jersey
WILLIAM CARNEY, New York
MARGARET M. HECKLER, Massachusetts
F. JAMES SENSENBRENNER, JR., Wisconsin
VIN WEBER, Minnesota
JUDD GREGG, New Hampshire
RAYMOND J. McGRATH, New York
JOE SKEEN, New Mexico
CLAUDINE SCHNEIDER, Rhode Island
JIM DUNN, Michigan
BILL LOWERY, California

HAROLD P. HANSON, *Executive Director*
ROBERT C. KETCHAM, *General Counsel*
REGINA A. DAVIS, *Administrator*
GERALD E. JENKS, *Minority Staff Director*

SUBCOMMITTEE ON ENERGY DEVELOPMENT AND APPLICATIONS

DON FUQUA, Florida, *Chairman*

TOM HARKIN, Iowa
JAMES J. BLANCHARD, Michigan
RICHARD C. WHITE, Texas
HAROLD L. VOLKMER, Missouri
HOWARD WOLPE, Michigan
BILL NELSON, Florida
ALLEN E. ERTEL, Pennsylvania
DAVE McCURDY, Oklahoma
ROBERT A. ROE, New Jersey
RICHARD L. OTTINGER, New York
JAMES H. SCHEUER, New York
MARILYN LLOYD BOUQUARD, Tennessee
ROBERT A. YOUNG, Missouri

HAMILTON FISH, JR., New York
F. JAMES SENSENBRENNER, JR., Wisconsin
VIN WEBER, Minnesota
JUDD GREGG, New Hampshire
JOE SKEEN, New Mexico
CLAUDINE SCHNEIDER, Rhode Island
RAYMOND J. McGRATH, New York
JIM DUNN, Michigan
ROBERT S. WALKER, Pennsylvania

DR. MARTHA KREBS, *Staff Director*
DR. EUGENE FRANKEL, *Science Consultant*

---

*On assignment to Budget Committee for 97th Congress.

CONTENTS

WITNESSES

July 22, 1982:	Page
Joseph J. Tribble, Assistant Secretary for Conservation and Renewable Energy, U.S. Department of Energy, accompanied by Maxine Savitz, Deputy Assistant Secretary for Conservation; and Robert L. San Martin, Deputy Assistant Secretary for Renewable Energy	11
John Cable, the Ehrenkranz Group, Washington, D.C	38
J. Douglas Balcomb, Los Alamos National Laboratory, Los Alamos, N. Mex	42
Ralph J. Johnson, president, NAHB Research Foundation, Rockville, Md., accompanied by Joe McGuire, director of regulatory affairs	57
Gardner McBride, Building Owners and Managers Association, International, Washington, D.C	95
John Eberhard, executive director, Advisory Board on the Built Environment, National Academy of Sciences	102
Dan Morgenroth, Owens-Corning Fiberglas, Toledo, Ohio	167
Appendix: Additional statement submitted for the record	204

BUILDING ENERGY RESEARCH

THURSDAY, JULY 22, 1982

HOUSE OF REPRESENTATIVES,
COMMITTEE ON SCIENCE AND TECHNOLOGY,
SUBCOMMITTEE ON ENERGY DEVELOPMENT AND APPLICATIONS,
Washington, D.C.

The subcommittee met, pursuant to notice, at 9:35 a.m., in room 2325, Rayburn House Office Building, Hon. Don Fuqua (chairman of the subcommittee) presiding.

Mr. FUQUA. Good morning. The subcommittee will be in order.

In April of this year our subcommittee received a proposal from 16 groups representing the building industry and the public interest community for a building energy research program. That proposal called for the integration of the DOE active and passive solar programs with the buildings and community systems conservation program into one overall research effort to improve the efficiency of American homes.

The Energy Development and Applications Subcommittee has consistently supported a closer integration of the DOE solar and conservation programs in the buildings area. At our hearings and in our authorization reports over the past 3 years, we have repeatedly called for closer cooperation between the two efforts. Mr. Fish, our ranking minority member, has been especially insistent on this point.

So we welcome this initiative by the building industry. Our principal question is how best to carry it out. Can it be done administratively by DOE, or will it require legislation? Will DOE accept the proposal if Congress appropriates money for it for fiscal year 1983? Does the program represent a radical departure from existing DOE efforts, or can it be integrated smoothly into the current structure? Are there research areas not covered by the proposal that we should consider? What will be the roles of the national laboratories and the building trade associations in planning and implementing this new program?

As you can see, we have probably more questions than answers for this hearing. However, we have a distinguished set of witnesses who should be able to address most of the issues that concern us. Our two panels consist of architects, engineers, builders, and researchers who are well known for their contributions to energy efficiency in buildings. Most of them have been involved with the DOE programs, in one capacity or another, for a number of years. Each has received a copy of the building energy research proposal for review, and we are looking forward to their views and recommendations.

THE BUILDING ENERGY RESEARCH PROGRAM

The Building Energy Research Program proposed by industry and the public interest groups is based on the following principles:

"1. Buildings should be treated as integrated and dynamic energy using systems".

"2. The research program should be based upon the actual behavior of occupied buildings."

"3. Residential and commercial buildings should be treated separately."

"4. The research program should be oriented toward the specific needs of those who will apply the results, namely homebuilders, architects, engineers, appliance and product manufacturers, retrofitters, building owners and occupants".

5. The research program is balanced between near and long-term development work.

6. An ongoing component of the program should be research into the health and safety of building energy systems.

The program includes basic research on materials, components and concepts; applied research including integration of research results, monitoring of performance, prototype development, and institutional research; and technology transfer and information dissemination. It distributes these activities among four classes of buildings: new residences, existing residences, new commercial buildings and existing commercial buildings. A copy of the proposal is attached.

THE BUILDING ENERGY RESEARCH PROGRAM

AN INTEGRATED APPROACH TO FEDERAL RESEARCH ON BUILDING ENERGY USE

APRIL, 1982

Developed through the cooperative efforts of representatives of the following groups:

American Council for an Energy-Efficient Economy
American Institute of Architects
Brick Institute of America
Building Energy Design Tool Council
Building Owners and Managers Association International
Energy Conservation Coalition
Environmental Policy Institute
Federation of American Scientists
International Union of Bricklayers and Allied Craftsmen
National Association of Home Builders
National Association of Home Builders Research Foundation
National Home Improvement Council
Northeast Retail Lumbermen's Council
Passive Solar Industries Council
Solar Energy Industries Association
Solar Lobby

BUILDING ENERGY RESEARCH PROGRAM

SUMMARY

A number of groups, representing the buildings sector and public interest concerns, are proposing the establishment of a comprehensive and integrated Building Energy Research Program. This program would consolidate the three primary federal research and development efforts concerned with buildings-related energy technologies: the Buildings and Community Systems Energy Conservation Program and the Active and Passive Solar Heating and Cooling Programs. Combining these elements into one program will permit more efficient usage of the very limited federal funds available for building energy research. And, perhaps more importantly, it will facilitate the examination of buildings as dynamic, integrated energy systems.

A comprehensive building energy research program is essential, because buildings use over a third of the nation's energy. To date, a number of federal programs have helped the nation's building industries make progress in developing ways to reduce the consumption of energy in this sector. But these programs have been organized around individual technologies, rather than in a coordinated approach to improve the overall energy efficiency of buildings. Similarly, these programs have placed insufficient emphasis on meeting the technical and informational needs of the individuals, organizations and businesses that actually construct and use buildings.

Despite these problems, progress has been made. Expertise has been developed on how to audit residential buildings for the efficiency of their energy use. Active and passive solar technologies are evolving, which permit dramatic reductions in the use of conventional energy in buildings. New, more energy-efficient products have been successfully tested and introduced for commercial application. These steps have happened as a result of federally-sponsored research and development.

An examination of the buildings sector reveals why, in addition to its potential for energy savings, a federally-supported energy use research program is needed. The building industry is decentralized, predominantly made up of many small-to-medium-sized firms involved in building construction or in the distribution of systems and components that go into buildings. This makes it very difficult for the industry to undertake a comprehensive energy research program. Building users are likewise very diverse, including major public and private institutions, small businesses, and individual owners and renters of single family homes and apartments. A coordinated federal research program is essential to address this wide range of interests in a meaningful way and to continue the nation's progress toward real energy efficiency in buildings.

The proposed Building Energy Research Program is an integrated and comprehensive approach to energy research which meets the needs of both building owners and occupants to reduce energy comsumption and of the building industry to develop cost-effective approaches to reducing conventional energy use. Key aspects of the proposal are:

1. Buildings should be treated as integrated and dynamic energy-using systems. This approach recognizes that greater energy efficiency can be attained by appropriate coordination of various energy technologies and components within a building or between a building and a larger community-scale system or utility grid. This approach also departs from the more traditional consideration of energy conservation and active and passive solar as separate technologies.

2. The Research program should be based upon the actual behavior of occupied buildings. Once again. this represents a departure from the present programs, which mainly model the behavior of occupied buildings on computers rather than gathering empirical data on them.

3. Residential and commercial buildings should be treated separately. These buildings have different design and construction techniques, different types of energy systems, and different use patterns. Research should be structured to recognize these differences. Moreover, within each of these categories, existing buildings are treated separately from new buildings, once again because the techniques involved in retrofit applications are quite different from those in new construction. (It is important to note here that, although it is much easier to incorporate energy efficiency improvements into new buildings, the potential for overall energy savings is much greater through the upgrading of the stock of existing buildings.) Finally, multi-family buildings are recognized as a unique problem in both the residential and commercial categories.

4. The research program should be oriented toward the specific needs of those who will apply the research results, namely homebuilders, architects, engineers, appliance and product manufacturers, retrofitters, building owners and occupants. This has not been sufficiently true of the existing programs. To provide the proper orientation, this proposal calls for the direct involvement of the various members of the buildings sector in the planning and direction of the research program. This kind of partnership can ensure that the resources for energy research of the federal government and of industry will be used

most efficiently. It is important to note that considerable data on building energy technologies has been developed through the existing research programs. Even though we are suggesting the redirection of these programs, this data remains valuable, and deserves continued analysis and application within the proposed program.

5. The research program is balanced between near and long-term development work. It is unrealistic to consider that all the federal government needs to support in this area is basic research. The most promising research in the buildings sector -- with respect to energy savings -- lies with nearer-term developments. But the nature of the buildings industry, as was described, makes sole support for them by the industry as difficult as support for long-term research. As in the past, however, the industry will continue to lend its resources where appropriate to the application of technologies and strategies developed through the proposed program.

6. An ongoing component of the program should be research into the health and safety aspects of building energy systems. Recent problems with the indoor air quality of super-insulated structures suggest that attention should be given to potentially adverse side effects of new energy systems and design strategies. This kind of research is most appropriate for the federal government, which is charged with protecting the public health and safety.

The groups that have worked together to outline the Building Energy Research Program are convinced that a tightly-managed research effort can achieve substantial results if funded at a level roughly equal to the sum of funding levels authorized by Congress for fiscal year 1982 operations of the Active and Passive Solar Programs and the Buildings and Community Systems Program. We are convinced that such an investment is essential if the nation is to realize the enormous energy savings possible through improvement of the existing stock of buildings constructed when energy prices were low. We are also convinced of the importance of achieving even higher efficiencies in new buildings. While each of the representative groups might emphasize different specific needs within the research program, we all strongly support the concept of an integrated national program.

PROGRAM SCOPE

For each area of concern (residential, commercial, new and existing) the Buildings Energy Research Program should support the following types of work:

BASIC RESEARCH

Research on materials, components, and concepts fundamental to energy-efficient buildings.

APPLIED RESEARCH

Research Integration - integration of basic research elements into buildings and energy systems, and monitoring and evaluation of their performance in occupied buildings to produce an accurate understanding of energy-conserving strategies.

Prototype Development - development of systems, components and building techniques that can be used to implement energy-conserving strategies in cost-effective ways.

Institutional Research - analysis of institutional barriers that impede development and utilitzation of energy-efficient techniques in buildings, and assessment of ways to mitigate them.

TECHNOLOGY TRANSFER AND INFORMATION DISSEMINATION - packaging of program results (information on products, components, systems and innovative institutional approaches) in forms useful to the individuals, organizations and businesses that are involved in the design, construction, purchase and use of buildings (including demonstrations to prove the feasibility of innovative building products, techniques and institutional approaches).

RESEARCH NEEDS

The following is a list of important research needs in the residential and commercial buildings sector, for both new and existing stock. It is not comprehensive; it is intended to show some areas of priority.

RESIDENTIAL BUILDINGS - NEW

Basic Research

- Thermal load dynamics within buildings.
- New thermal storage and glazing materials.
- Building environmental quality (e.g. indoor air quality).
- Building materials and system controls.
- Research leading to high-efficiency appliances.
- Research leading to high-efficiency heating and cooling systems.

Applied Research

- Collection of data on thermal behavior of occupied buildings.
- Integration of solar systems with conventional heating and cooling systems.
- Collection of cost and performance data on integrated systems in various climatic regions.
- Assessment of the impact of energy efficient buildings on utility load management.
- New technologies for community-scale systems.
- Prototype development of thermal storage and building envelope materials and components, active and passive solar systems.
- Documentation and analysis of institutional decision making processes which affect the development and adoption of energy conserving strategies by end users (financial institutions, buildings owners, state and local governments).

Technology Transfer and Information Dissemination

- For homebuilders and construction trades (e.g. design innovations and construction techniques).
- For product manufactuers (e.g. performance data).
- For financial institutions (e.g. impact of energy systems and strategies on capital and operating costs).

- For building owners and occupants (e.g. operating costs).
- For local governments and utilities (e.g. innovative institutional approaches).

RESIDENTIAL BUILDINGS - EXISTING

Much of the necessary research is similar to that needed for new residential buildings. There is, however, an additional need to address the following:

Basic Research

- New retrofit materials.
- Cost-effective retrofit techniques to mitigate inflitration and conduction losses.

Applied Research

- Collection of cost and performance data on buildings before and after retrofit.
- Prototype development of packaged retrofit systems.
- Analysis of how relationships between building owners and renters affect energy decisions.

Technology Transfer and Information Dissemination

- For home owners, product and system distributors and remodelling contractors -- a much more dispersed set of industries than those involved with new buildings (e.g. retrofit manuals).
- Information on innovative delivery systems for local governments and utilities (e.g. one-stop-shop energy programs).

COMMERCIAL BUILDINGS - NEW

Basic Research

- New building shell and glazing materials (e.g. to reduce night heat loss).
- Building environmental quality (e.g. indoor air quality).
- Advanced lighting and HVAC systems and controls.
- Heat recovery systems.

Applied Research

- Analysis of energy dynamics and control strategies for complex, multi-zone buildings.
- Assessment of interrelationships between active and passive heating and cooling systems (and daylighting), and their integration with conventional systems, according to various building types and climatic regions.
- Collection of cost and performance data by building type and climatic region.
- Prototype development of HVAC systems - (e.g. for individual building zones), lighting systems and strategies, heat recovery systems, and glazing systems.
- Assessment of financial and institutional factors affecting energy decisions by building owners (including concerns of financiers and occupants).

Technology Transfer and Information Dissemination

- For architects, engineers and developers (e.g. design and analysis tools that accurately predict building performance).
- For financial institutions (e.g. impact of energy systems and strategies on capital and operating costs).
- For building owners and occupants (e.g. operating costs).
- For product manufacturers (e.g. performance data).
- For local governments and utilities (e.g. innovative institutional approaches).

COMMERCIAL BUILDINGS - EXISTING

Much of the necessary research is similar to that needed for new commercial buildings. There is, however, an additional need to address the following:

APPLIED RESEARCH

- Monitoring performance of buildings before and after retrofit.
- Improvement of operating efficiency of existing systems (e.g. through improved maintenance).

- Development of more efficient HVAC and lighting retrofit strategies, and of smaller, more efficient prototype replacement systems.
- Development of energy retrofit techniques that meet other rehabilitation requirements (e.g. for fire protection, structural integrity and building safety, among others).
- Analysis of how relationships between building owners and occupants affect energy decisions.

Technology Transfer and Information Dissemination

- For architects and engineers (e.g. cost and performance data on retrofit strategies).
- For product manufacturers (e.g. product performance data).
- For utilities, local governments and energy management companies (e.g. innovative institutional approaches).

Our first witness is Mr. Joseph Tribble, the Assistant Secretary for Conservation and Renewable Energy at the Department of Energy.

Mr. Tribble, we realize that the administration did not ask for funds for the program areas covered by today's hearing in its fiscal year 1983 budget request, but we appreciate your willingness to testify today and to help us assess the merits and feasibility of this proposal. We are pleased to have you, along with Dr. San Martin and Dr. Savitz. We would be pleased to hear from you at this time.

STATEMENT OF JOSEPH J. TRIBBLE, ASSISTANT SECRETARY FOR CONSERVATION AND RENEWABLE ENERGY, U.S. DEPARTMENT OF ENERGY, ACCOMPANIED BY MAXINE SAVITZ, DEPUTY ASSISTANT SECRETARY FOR CONSERVATION, AND ROBERT L. SAN MARTIN, DEPUTY ASSISTANT SECRETARY FOR RENEWABLE ENERGY

Mr. TRIBBLE. Thank you, Mr. Chairman.

I was going to introduce my colleagues, but I am sure you know them both.

Mr. FUQUA. They have been here many times.

Mr. TRIBBLE. We are pleased to be here again, this time to discuss that part of the Department of Energy's conservation and renewable energy program that deals with building energy research.

The Nation's buildings consume more than one third of the Nation's energy, and there is a great opportunity for cost-effective improvements in the efficient utilization of energy in buildings.

The building industry is very fragmented and contains many relatively small businesses. It is difficult, therefore, for these individual businesses to focus on research and development which serve a common interest. However, by pooling resources through participation in various trade associations, the industry has the opportunity both to originate and finance the solutions to many common problems.

We would encourage the industry trade associations to pursue this opportunity and to move to reduce and eventually eliminate dependency upon the Federal Government for research, except perhaps that of a very basic nature.

The committee has requested that we address three specific questions: Our opinion on the desirability of consolidating the research programs of all the offices which now do work related to buildings into one office; two, whether or not this could be done under present legislative authority; and, three, our comment on the merits of the proposed research program.

To address the first and second questions, the present organization is, to a large extent, already in the process of becoming consolidated. As you know, it is all in one office of the Assistant Secretary, and as DOE research activities in the buildings area become more focused on longer term and generic research, it will be easier for any information related to subjects to be communicated between the offices.

We have had a great deal of cooperation between the work that relates primarily to solar and the work that relates primarily to the building side of a house, and we feel that that cooperation has been very good.

We continually review our organizational structure with improved efficiency in mind. When and if changes are needed, we can make them within the existing legislative authority.

We will address the third question in considerable detail. However, before doing so, we should emphasize the cooperative relationship which has existed between the conservation and renewable energy and many of the organizations that have participated in the development of the proposed program.

We have worked with the American Institute of Architects in many ways, most recently by helping underwrite a series of nationwide training workshops on energy-efficient design. We are working with the American Council for an Energy-Efficient Economy in a workshop later this summer that will seek to document the results of energy conservation in buildings.

The Building Owners and Managers Association provided expert advice when DOE was required to quickly implement the emergency building temperature restrictions. We have supported NAHB and the NAHB Research Foundation in a program that monitors the energy use of high performance residences.

DOE provided the initial grant to found the Passive Solar Industries Council, serving the Brick Institute of America, the International Union of Bricklayers and Allied Craftsmen, the Northeast Retail Lumbermen's Council, and other organizations. We are also financially supporting the National Institute of Building Science.

DOE has developed plans for building research in close cooperation with leading experts from private firms and universities. A good example of such cooperation is the national program plan for the thermal performance of building envelope systems and insulating materials. A committee of knowledgeable industry and education leaders participated in the preparation of the original plan issued in January 1979 by providing review, guidance, and advice. The plan called for an independent council broadly representative of the building community to be formed, to promote Government and industry cooperation in the planning, support, execution, and implementation of the national program plan.

The national program plan is so named because its implementation depends upon participation and financial support by all sectors

of the building community both public and private. The updated national program plan, published in March 1982, was prepared with the assistance of 38 contributing writers from industry, educational, and governmental organizations who submitted technical materials. Seventeen additional organizations submitted recommendations, additions, interpretations, and corrections to improve the draft. Of the 576 copies of the draft circulated outside the lab, 423 went to interested organizations and individuals. This afforded a representative cross section of affected individuals and organizations an opportunity to provide input.

Many of those contributing to the building energy research program now before this committee and representatives of their membership worked together to specify what they believe are the most important areas that public and private researchers should address.

We want to be certain that any research we assist in funding is in fact that which serves the proper interest of both the industry and the Federal Government. Continued cooperation, as mentioned above, will assure that the respective roles will be understood to avoid needless duplication and/or omission.

Mr. Chairman, in my formal testimony, using the headings of the proposed building energy research program, we mention a number of activities that we have either done or are doing. Rather than reiterate those statements, suffice it to say that we are in general agreement with the program as an overall plan for both the Federal Government and the private sector.

We should also comment that we in DOE have spent $266 million on items related to the subjects and the program plan.

It appears that information exchange could be improved. Collectively, we have the know-how to build energy-efficient buildings. We generally know the cost-effectiveness of most conservation measures. Relatively little additional research is necessary. However, we do need to make the knowledge more readily available. We will be doing this this year through the BEPS program. We expect to generate handbooks, written in easy-to-understand language, which address many of the subjects of the proposed program.

One effective way to disseminate this information will be through the publications of the trade associations. We look forward to continuing to work cooperatively with the organizations which have proposed this building energy research program.

We probably should change the name because the acronym is a little disturbing. We would not like to have this program called BERP.

We would be pleased to respond to your questions and those of the subcommittee.

[The prepared statement of Mr. Tribble follows:]

11-221 O—82——2

TESTIMONY OF

JOSEPH J. TRIBBLE

ASSISTANT SECRETARY

CONSERVATION AND RENEWABLE ENERGY

BEFORE THE

ENERGY DEVELOPMENT AND APPLICATIONS SUBCOMMITTEE

HOUSE SCIENCE AND TECHNOLOGY COMMITTEE

JULY 22, 1982

Testimony by Joseph J. Tribble

Energy Development and Applications Subcommittee

House Science and Technology Committee

July 22, 1982

I welcome the opportunity to appear again before this Committee, this time to discuss that part of the Department of Energy's Conservation and Renewable Energy Programs dealing with building energy research.

The Nation's buildings consume more than one-third of the Nation's energy, and there is great opportunity for cost-effective improvements in the efficient utilization of energy in buildings.

The building industry is very fragmented and contains many relatively small businesses. It is difficult for these individual businesses to focus on research and development which serves a common interest. However, by pooling resources through participation in various trade associations, the industry has the opportunity both to originate and finance the solutions to many common problems. We would encourage the industry trade associations to pursue this opportunity and move to reduce and eventually eliminate dependency upon the Federal Government for research except perhaps that of a very basic nature.

The committee has requested that we address three specific questions: (1) Our opinion on the desirability of consolidating the research programs of all the offices which now do work related to buildings into one office, (2) whether this could be done under present legislative authority, and (3) our comment upon the merits of the proposed research program. To address the first and

second question, the present organization to a large extent is already in the process of becoming consolidated. As DOE research activities in the buildings area become more focused on longer term and generic research, it will be easier for any information related to subjects to be communicated between the offices. We continually review our organizational structure with improved efficiency in mind. When and if changes are needed, we can make them within existing legislative authority. We will address the third question below in considerable detail. However, before doing so we should emphasize the cooperative relationship which has existed between Conservation and Renewable Energy and many of the organizations that have participated in the development of the proposed program.

We have worked with the American Institute of Architects in many ways, most recently by helping underwrite a series of nationwide training workshops on energy efficient design. We are working with the American Council for an Energy-Efficient Economy in a workshop later this summer that will seek to document the results of energy conservation in buildings. The Building Owners and Managers Association provided expert advice when DOE was required to quickly implement the Emergency Building Temperature Restrictions. We have supported NAHB and the NAHB Research Foundation in a program that monitors the energy use of high performance residences. DOE provided the initial grant to found the Passive Solar Industries Council, serving the Brick Institute of America, the International Union of Bricklayers and Allied Craftsmen, the Northeast Retail Lumbermen's Council and other organizations. We are also financially supporting the National Institute for Building Science.

DOE has developed plans for building research in close cooperation with leading experts from private firms and universities. A good example of such a plan is the National Program Plan for the Thermal Performance of Building Envelope Systems and Insulating Materials. A committee of knowledgeable industry and education leaders participated in the preparation of the orignial plan issued in January 1979, by providing review, guidance and advice. The plan called for an "independent council broadly representative of the building community to be formed to promote government/industry cooperation in the planning, support, execution and implementation of the National Program Plan."

The National Program Plan is so named because its implementation depends upon participation and financial support by all sectors of the buildings community--public and private. The updated National Program Plan published March 1982 was prepared with the assistance of 38 contributing writers from industry, educational and governmental organizations who submitted technical materials. 17 additional organizations submitted recommendations, additions, interpretations and corrections to improve the draft. Of the 576 copies of the draft circulated, 423 went to interested organizations and individuals outside the laboratory. This afforded a representative cross-section of affected individuals and organizations an opportunity to provide input.

Many of those contributing to the Building Energy Research Program now before this committee, and representatives of their membership, worked together to specify what they believe are the most important areas that public and private researchers should address.

We want to be certain that any research we assist in funding is, in fact, that which serves the proper interests of both the industry and the Federal Government. Continued cooperation as mentioned above will assure that these respective roles will be understood to avoid needless duplication and/or omission.

Turning now to the specific recommendations of the proposed building energy research program, the Department has had a comprehensive research program in virtually all of the areas outlined in the report. The following illustrates these research efforts in the new residential area. For ease of comparison, the same research subtopics contained in the report are used.

Research Need for New Residential Buildings

Basic Research

o Thermal load dynamics within buildings. Since 1976, DOE has been developing algorithms to account for thermal mass in buildings. The analytical work has been performed by the Lawrence Berkeley Laboratory (LBL) and the Los Alamos National Laboratory. Experimental work includes measurements of thermal mass effects in instrumented test cells at the National Bureau of Standards (NBS) and at the New Mexico Energy Institute. The solar passive program has done related work to understand the heat transfer dynamics of radiation, convection, and conduction at the relatively low differentials that characterize buildings heated and cooled by natural means.

o New thermal storage and glazing materials. Basic research on glazing materials has been going on at LBL since 1976. Heat mirrors, kinetic coatings,

holographic films, nitride and carbide coatings and aerogels are among the materials studied or being studied. The solar program has undertaken research on chemical conversion absorber coatings, advanced flat plate glazing systems, the kinetics of glycol degradation, the flame spread of glazing materials, absorptive and cover plate materials, and heat mirrors and other selective optical filters. The solar passive program in related experimental studies is determining heat transfer correlations for different building geometrics and energy flows and is investigating new technologies to increase the thermal storage capacity of residential buildings, currently constructed of light frame, low mass materials. Some relevant work on polymer materials will continue next year in the solar thermal program. Much of the basic research in the area has been completed and further developments are being taken over by the private sector. (PPG, 3M and Ford are pursuing work in this area.)

o Building environmental quality (e.g. indoor air quality). LBL has been conducting basic research since 1977 in monitoring and controlling indoor air contaminants, ventilation, and infiltration. Systems and devices for measuring infiltration rates and various contaminants (e.g., formaldehyde and carbon monoxide) have been, and are now being, developed. Control systems, such as air-to-air heat exchangers and filtration devices, have been investigated.

o Building materials and system controls. Oak Ridge National Laboratory (ORNL) is our lead laboratory in the building envelope materials program that has been underway since 1976. The research has ranged from the study of energy transport in porous materials to investigations of urea-formaldehyde foams. Working with the building industry and design professions we have just updated the National Program Plan for Building Thermal Envelopes and Insulating Materials, mentioned

above, that defines the research needed in this area. Much of this research will be done by private industry. In 1977, we initiated a controls program at our Brookhaven National Laboratory (BNL) and have done considerable work there and at NBS. No further federal effort is warranted.

o Research leading to high-efficiency appliances. Over the past 5-10 years, DOE has supported the development of numerous high efficiency appliances. DOE research has improved the understanding of materials and basic physical and chemical processes and their control, has identified potential new technical approaches in advanced appliance technologies in mechanical, heating, and refrigeration applications.

o Research leading to high-efficiency heating and cooling systems. The active solar program pursues systems integration analyses and test and performance measurement programs leading to high efficiency heating and cooling systems. Corrosion studies and maintenance analyses have been conducted to assure higher efficiencies for the entire system cycle. Conservation research has improved the understanding of materials and basic physical and chemical processes and their control, and identified potential new technical approaches in advanced heating and cooling technologies involving oil, gas, and solid fuel combustion and heat pump drive and refrigeration processes.

Applied Research.

o Collection of data on thermal behavior of occupied buildings. DOE has been collecting detailed and general data on the thermal behavior of new occupied residences since 1976 when research commenced on the Minimum Energy Dwelling

(MED) homes in Southern California. The National Solar Data Network (NSDN) has used sophisticated instrumentation to measure thermal behavior of new and existing buildings. Continuing conservation work has ranged from a series of residential case studies of particularly energy efficient homes to detailed monitoring of townhouses.

o Integration of solar systems with conventional heating and cooling systems. The solar program is making comparative analyses to optimize the use of solar active, passive, and conventional systems. Major projects include solar-assisted heat pumps and the U.S. Air Force Academy's solar pond program, among others.

o Collection of cost and performance data on integrated systems in various climatic regions. The National Solar Data Network program presently compiles cost and performance data on solar systems in various climate regions. The research work for Building Energy Performance Standards has compiled an immense amount of data on the cost and performance of different energy efficiency systems in different climates.

o Assessment of the impact of energy efficient buildings in utility load management. The Department is working with utilities, as well as consumers, in the implementation of the Residential Conservation Service to identify the energy saving effects of a broad residential audit and retrofit program. In Lakewood, New Jersey, DOE is supporting a pioneer project where a utility would "purchase" the saved energy of a retrofit project-- forestalling its need to build new generating facilities. The Integrated Community Energy System (ICES) program has demonstrated how small district heating systems can be connected successfully into larger utility grids.

o New technologies for community-scale systems. DOE has supported the application of new hot water district heating technologies through feasibility studies and technical assistance in more than 30 U.S. cities. Support has also been given to innovative municipal waste-to-energy research projects. Solar work includes research on solar ponds, pond layer hydrodynamics, control methods, and instrumentation.

o Prototype development of thermal storage and building envelope materials and components, active and passive solar systems. The Brookhaven house is just one example of DOE field validation research into the interaction of prototype thermal storage building envelope materials and systems, and passive solar systems. Solar work is directed toward phase-change thermal storage devices for higher temperature applications. Work in this area dates back to 1976.

o Documentation and analysis of institutional decision-making processes. The Comprehensive Community Energy Management and Planning program has supported cities and counties in the development of plans for increasing their energy efficient construction, and has supported seminars on the subject. We have been working with professional organizations to encourage the inclusion of our research results in their publications (e.g. ASHRAE's Handbook of Fundamentals). We also work closely with industry to help develop consensus standards (e.g. ventilation, building air-tightness, and infrared thermography standards). The solar program currently is closing down its demonstration program and transferring all the data collected to private industry.

o For product manufacturers. The DOE has developed test procedures used by manufacturers to measure the energy efficiency of their products. In addition,

DOE has done considerable research supporting the development of industry consensus standards for test procedures and methods. One example of this is the building thermal envelope systems and insulation materials (BTESIM) program which has a long history of close cooperation with product manufacturers. DOE's windows and daylighting program at LBL also has worked closely with product manufacturers in making basic materials research results available. In the solar program, the NSDN is used to transfer technology to manufacturers.

o For financial institutions. Working closely with the financial and building community, DOE is seeking to gain recognition by financial institutions of the market value of energy-efficient homes. The effort is aimed at developing voluntary home energy rating systems. Buyers would be allowed mortgages with higher debt to income ratios on energy-efficient homes because their lower energy costs would enable them to make higher mortgage payments.

o For building owners and occupants. DOE's appliance testing program provides technical support to the Federal Trade Commission's appliance labeling program that provides consumers information on the comparative energy efficiency and costs of major household appliances. A public information program has informed consumers of the labeling program.

o For local governments and utilities. DOE is providing seed funding to help start the National Community Energy Management Center, which is providing information on conservation programs for local governments. Working with utilities, DOE has developed model residential energy audit techniques, field tested the model audit, and transferred the results to utilities.

This lengthy summary describes only the work DOE has done related to new residences in the area which the Research Program report says should be given high priority. Much of this work also would be applicable to existing residences. DOE has undertaken a similar, broad research program in the commercial building area.

DOE recognizes the merit of the proposed research program from the points of view of groups that have cooperated to produce this report. We want to work with them to be responsive to their suggestions. We recognize the building industry is hard pressed as we move toward a healthier economy. At the same time, the mandate for Federal fiscal constraint means DOE must focus its limited resources on the highest priority research areas. We are confident that, given a chance, the President's Economic Recovery Program will lead to improvements in the buildings sector that will allow the building industry trade associations to pursue this research program more aggressively.

As the research program moves forward we would appreciate recommendations with a high degree of specificity. The above suggests that improvement is needed in information exchange--government to industry, industry to government and within industry. The trade association publications could be a valuable tool with which to accomplish this.

In conclusion, we believe that our interests coincide with those of the buildings industry. We look forward to continuing to work cooperatively with these fine organizations in the interests of the Nation.

Mr. FUQUA. Thank you very much, Mr. Tribble.

The building energy research program, as described by the consortium, do you think it is desirable and a workable plan?

Mr. TRIBBLE. Yes. It certainly addresses many of the problems that the building industry faces. As I mentioned, many of those things that have been suggested have been done and are accounted for in the longer text of the testimony that I submitted for the record.

We need to look very carefully at the proposals to determine, one, what is being done in the private sector and also to be sure that we do not redo something that we have already done and then concentrate on those things that we feel will be most worthwhile to the industry.

Mr. FUQUA. Can it be implemented by DOE administratively, or is it going to take new legislation, or is it going to require maybe an internal reorganization?

You mentioned that building energy research has been consolidated within DOE now, but can this program be done administratively in DOE?

Mr. TRIBBLE. Yes. We feel that we have adequate authority to go forward with almost any program of this nature, of course within the constraints provided by the Congress, and we do have the authority to reorganize, if that seems to be desirable.

Mr. FUQUA. Do you think it would be necessary to reorganize?

Mr. TRIBBLE. No, I do not.

Mr. FUQUA. Or perhaps some structural changes?

Mr. TRIBBLE. There may be some changes as we go—consolidations and things of this nature—but I feel that the present organization is quite adaptable to any problems that we have.

Mr. FUQUA. You are, in effect, saying that it would not pose any managerial or organizational problems within DOE?

Mr. TRIBBLE. That is right.

Mr. FUQUA. If Congress were to provide the needed funds, would DOE be willing to implement them?

Mr. TRIBBLE. When you say "implement them"——

Mr. FUQUA. I mean utilize them as Congress directed.

Mr. TRIBBLE. There is no question about that. Yes, we would be——

Mr. FUQUA. Be careful now. You know, OMB sent out a gag rule the other day.

Mr. TRIBBLE. Well, of course, when the Congress mandates that we spend money on certain things, we feel that that is a mandate, and we expect to carry out the law.

We would hope that we would be given substantial flexibility in selecting the projects that we spend money on, because I think the testimony that you will hear today will in fact reflect the circumstance that there needs to be a better interchange of information.

A lot of things have been done that apparently are not known widely, and I am sure that none of us wants to do those things again. So before we undertake additional programs, it would certainly be in everyone's interest to examine carefully what has been done so that we do not reinvent the wheel.

Mr. FUQUA. The people that came up with this program said it represents a significant departure from DOE practice, especially in-

sofar as research is oriented toward the behavior of occupied buildings or oriented toward the ultimate user. Do you think that that is a significant departure from DOE policy? Is it a desirable departure?

Mr. TRIBBLE. We do not think it is as significant a departure as this proposal would make it appear. There have been many instances—I would say hundreds of instrumented buildings—that we have collected data on, that are in the occupied category. So this is another one of those situations where what has been done may not be fully understood.

But we certainly have looked at heat transfer, both in hotboxes and the static circumstances. We have also taken into consideration the dynamic influences on these buildings, and wall sections, and roof sections. We have collected a world of data on occupied buildings, and so we do not think that looking at the occupied building characteristics is a substantial departure from what we have done.

Mr. FUQUA. How about aiming the program toward the ultimate user—the end user of the building?

Mr. TRIBBLE. I am sorry, but I do not believe I understand the question.

Mr. FUQUA. Who is going to use the building? How will it be utilized? Aiming at a practical and applied program rather than a basic research program?

Mr. TRIBBLE. Well, let us talk about that a little bit.

Mr. FUQUA. Let me read you what they said. They said, "The research program should be oriented toward the specific needs of those who will apply the results—namely, home builders, architects, engineers, appliance and product manufacturers, retrofitters, building owners, and occupants." So it is really the user community.

Mr. TRIBBLE. All of us have different living habits. Some of us open and close the doors, and the kids leave them open. Some of us close them when we go through them.

Mr. FUQUA. My habits changed this week when my air-conditioner went out. [Laughter.]

Mr. TRIBBLE. So I would say it is almost an impossibility to address all of the various circumstances that are created by the various living styles that American people choose.

If we do research and do work that will, in fact, demonstrate the energy efficiency of the buildings, then we think we will have served our purpose and that the living style that a person chooses will be up to that family, and they will either benefit from their conservation activities or suffer from their extravagances.

So we think that if we do the work that is more basic, that tells us what the energy consumption under a given set of circumstances are, so that that can be related one to another, then we will have accomplished our purpose.

Mr. FUQUA. What role do you see for the national laboratories in carrying out the research programs—particularly the laboratories that have been involved in solar and conservation, such as SERI, Lawrence Berkeley, Oak Ridge, or Los Alamos.

Mr. TRIBBLE. As you know, we have facilities at most of those that you mentioned, and we have done a great deal of work there,

in hotboxes and the transfer of heat and moisture through wall and roof sections; we have done substantial data collecting through Oak Ridge. We really feel that we have done about enough at this time and that we should examine the information we have and see if there is anything further that can justifiably be done.

Mr. FUQUA. Would you propose that they continue to transfer the information that they have gathered to the building industry?

Mr. TRIBBLE. Very definitely.

Let me mention one thing that we are doing under the BEPS program. I mentioned it earlier, but perhaps it needs a little elaboration.

At LBL we will be analyzing the following conservation strategies: 15 combinations of insulation and glazing; variations in area of glazing, and the distribution of glazing; movable night insulation; shading of glass; variation in air infiltration; different equipment efficiencies; variations in building shapes; we will be doing all of that——

Mr. FUQUA. Is that in fiscal year 1983?

Mr. TRIBBLE. Fiscal year 1982, with 1982 funds.

Mr. FUQUA. What about 1983?

Mr. TRIBBLE. We think we will have it done in 1982.

We are doing that, not just for one type of building, but we are doing it for an outside townhouse, an inside townhouse, a single-family dwelling, residential buildings of various representative types, and we further expect to gather all of this information into handbooks written in language that is easily understood not only by the architects and engineers but also by the people—the crafts—and have this available to anyone who wants to use it. We will be able to do this with the BEPS funds for 1982, and we think that this will go a long way toward getting the information available so that it can be put in the hands of those who need it.

Mr. FUQUA. Are there any areas of applied research anywhere in the building energy program proposal which you believe do not meet the administration criteria?

Mr. TRIBBLE. I do not know that—you see, most of these recommendations are relatively general.

Mr. FUQUA. I am not speaking of a specific project necessarily.

Mr. TRIBBLE. We would like to have suggestions of a more specific nature. Generally speaking, we have addressed and would expect to address any of the problems that are problems to the building industry, because that would be what we would expect this program to accomplish.

I do not know that I could categorically say each and every one of these suggestions is something we would feel we should spend money on.

Mr. FUQUA. Thank you.

Mr. Skeen.

Mr. SKEEN. I have no questions, Mr. Chairman.

Mr. FUQUA. Mr. Nelson.

Mr. NELSON. Thank you, Mr. Chairman.

Good morning, Mr. Tribble.

Mr. TRIBBLE. Good morning.

Mr. NELSON. Over the past few years there has been a continuing downward trend in funding of your particular aspect of the Department of Energy.

Mr. TRIBBLE. Yes.

Mr. NELSON. Do you have any hard evidence that what we have embraced here in concept as needing to be increased—efficiency in buildings, residential and commercial, old and new—do you have any hard evidence that industry is going to pick up the tab for this, as opposed to the seed money coming from the Department of Energy?

Mr. TRIBBLE. We feel that we collectively know how to build an energy-efficient building and that the technique or the design of a building is more now a question of economics than lack of knowledge.

We have buildings that are built that do not even require external sources of heat in relatively cold climates. So we feel that most of the research of a research nature is behind us. We think we know what to do, if it is economically justified, and we feel that one of the things that we need to do is get this information into the hands of the people who can make the decision in the various climates throughout the country as to what makes sense to them in that location under the current economic circumstances.

As I am sure you know, one of the problems now with building an energy-efficient home is interest rates—building any home for that matter.

On the other hand, the things that have been developed, particularly through the passive program, add relatively little to the cost of a building. There are things that can be done that pay out in a short time.

So we think that if we can get this information into the hands of the people who designed the buildings and the people who are responsible for building them, that we will have served that purpose, and this is one of the reasons why we feel justified in asking for less money now, because we really feel that most of the work that needs to be done has been done.

Mr. NELSON. Do you have any hard evidence that this information that you are going to disseminate has or will be used?

Mr. TRIBBLE. Yes. We have—I do not have them with me, but there are a number of advertisements that I have in a file in my desk drawer showing the many builders that are in fact advertising their buildings as being energy efficient and are pointing to the things that they have accomplished as a sales gimmick.

I know from personal experience that a number of the builders are incorporating conservation measures in most of the homes that they are building now.

Mr. FUQUA. Would the gentleman yield?

Mr. NELSON. Surely.

Mr. FUQUA. I hope I am not interrupting him.

Mr. NELSON. No, not at all.

Mr. FUQUA. Mr. Tribble, you say that we have done all the work that needs to be done. I hope we are not in the situation that Congress found itself in many years ago when Daniel Webster was a Member of the Senate and proposed that we close the Patent Office because everything had been invented that needed to be invented.

Mr. TRIBBLE. No, we are not in that posture, Mr. Chairman.

Mr. FUQUA. OK.

Mr. TRIBBLE. We think that there are some things that do need to be done;. As a matter of fact, we are planning to go forward with some rather innovative ideas.

One of the things that we would like to pursue is a glass or a transparent medium that could be conductive when we want it to be conductive or at least let the Sun's rays through when we would want them and at the same time be able to block them out when we chose to do so, and to make it, if you will, switchable.

As you know, there is a great deal of the heat loss and heat gain that does take place through the apertures of buildings, and if we can come forward with a technology that will enable us to limit that in the direction that we want it, then we think this will make a giant step toward improvement.

Mr. FUQUA. We have some of that now, do we not?

Mr. TRIBBLE. Yes.

Mr. FUQUA. I know that in eyeglasses or in sunglasses we have that.

Mr. TRIBBLE. That is right. We would hope to build on that technology and come up with, if you will, a switchable medium.

There are other things of that nature that we intend to pursue and have proposed to do so. For example, in the question of environmental question—in air quality in the homes when infiltration is reduced—we are proposing to develop low-cost instrumentation which will enable us to recognize any build up of impurities in the air that may be harmful. And there are others, of course, that we are going forward with.

But from the standpoint of heat transfer or location of windows and shading and arrangement on the lot, outside exterior shading with deciduous plants, and things of that nature, that kind of work we feel we have done all we should do on, and we should move into the more research type of activity.

Mr. NELSON. What have you done, for example in shading? You say you have done all you should do.

Mr. TRIBBLE. This has been largely an adaptation of commonsense.

Mr. NELSON. You are talking about research?

Mr. TRIBBLE. Yes.

Mr. NELSON. I am talking about dissemination.

Mr. TRIBBLE. What have we done?

Mr. NELSON. Builder X in Muskogee is going to build a subdivision. What do you have in your program that you are doing or expect to do that would disseminate information as to the most energy-efficient way to build that subdivision?

Mr. TRIBBLE. We have had numerous studies made, and the reports of those are available through the Technical Information Center, some through the Government Printing Office, and many through the National Technical Information Service. You can go and get a book on just about any kind, whether windows, doors, wall sections, roofs—almost any portion of a building.

There is a DOE report that will be give you sometimes more than you want to know about it.

Mr. NELSON. I guess what I am asking is whether or not this is being implemented back in the communities across America. Would you all be the repository of that information, or would one have to go to each State, or are the States the repository?

Mr. TRIBBLE. We are a repository. On the other hand, it is available through all of the State energy offices, and it is being picked up in many instances by the trade associations.

If you look in the publications of the trade associations, many times you will see where certain documents are available from a given source.

So I think that kind of dissemination is, in fact, taking place. However, if we can assist it, we think we should.

Mr. NELSON. Is there any evidence that there is an incentive for the builder to build an energy-efficient home? Are consumers asking for it?

Mr. TRIBBLE. Very definitely.

Mr. NELSON. You have evidence of that?

Mr. TRIBBLE. I do not know that we—let me ask my cohorts if we have any of the type of evidence—I know from my own personal knowledge that it is true, but I do not know that I have anything on a piece of paper that says it is true.

Do you know of any?

[Mr. Tribble confers with his staff.]

Mr. TRIBBLE. I am just told that an NAHB survey indicates that 89 percent of the people who buy new homes consider energy as a most important feature.

Mr. NELSON. What about rehabilitation of old homes?

Mr. TRIBBLE. This certainly is an area that deserves a lot of attention.

One of the things that we would like to see is an insulation that could be used—say, if you will, a foamed-in-place or some such type insulation—because, as you know, there are a tremendous number of homes that were built when energy was cheap, and they are simply energy inefficient.

If there is some economical way of retrofitting these buildings, we would certainly like to push that. On the other hand, we feel that we must be careful, because certainly the insulation companies and the chemical companies who have this interest have an interest in doing this same thing.

We would like to see it done. We would rather they do it, and we would not like to be doing it if they are doing it, and we really need to have better communication between ourselves and the industry so that we will not be doing things they are doing. But it certainly is something that needs to be done.

Mr. NELSON. Mr. Chairman, let me ask you a question. The tiles for the Space Shuttle have turned out to be very successful as an insulator. Have you seen any spinoff technology for applying that technology to insulation in homes?

Mr. FUQUA. I think there may be some work going on examining the purity and so forth of those tiles. It is of such a nature that I do not think they would really have a commercial application except in rare instances, but I think industry is looking at some of the materials.

Mr. TRIBBLE. That technology is looking at temperatures that are quite high, that really would not be applicable from a building standpoint except in the heating equipment.

Mr. NELSON. On page 10 of your statement, it says, "DOE must focus its limited resources on the highest priority research areas." Why is the work in DOE that you head up—energy efficiency in buildings—not considered high priority, as measured in the amount of dollars that is allocated, and how are those priorities set?

Mr. TRIBBLE. As I mentioned earlier, we think that most of the work that needs to be done from a heat transfer and moisture migration point of view has been done, so that we should not necessarily spend anything great on that.

We feel that we should go forward with the kind of thing that I mentioned earlier, such as the indoor air quality instrumentation, the more researchy developments that will, if you will, give us a much better insulation or permit us to retard the heat flow through glass.

We have gone through all of the proposals for work of this nature and more or less narrowed it down to those that we thought hold great promise and that are in the category that are not likely to be done by the private sector but nevertheless, if done, would be of maximum benefit to the Nation as a whole.

Mr. NELSON. And you think that within DOE those are given highest priority?

Mr. TRIBBLE. I do not know what you are saying relative to, but we think that they are being given adequate priority.

Mr. NELSON. I just want to make a statement in conclusion, Mr. Chairman. It is sort of something of a prophesy. In 1973 when we had our first cutoff of oil, the Nation went back to sleep after we got through our initial inconveniences. Then in 1979 we seemed to wake out of our slumber after three Presidents had tried to rally us and the Nation did not pay any attention to the energy crisis.

What took place this past week—when Iran attacked Iraq—is just a foretelling of events to come. The consequences of that, as it rumbles throughout the Persian Gulf region will have a significant effect upon us. So it might not be too far off in the future when DOE, and specifically your part of DOE, might be given a lot more attention if the oil suddenly starts to lessen in its flow out of those sealanes coming out of the Persian Gulf.

Thank you, Mr. Chairman.

Mr. FUQUA. All I can say is amen.

Mr. Fish.

Mr. FISH. Thank you, Mr. Chairman.

Mr. Tribble, following up on the line of questioning you were just asked about sources of information, I recall that we had the regional solar centers, the Energy Extension Service, the Residential Conservation Service, the National Conservation and Renewable Energy Hotlines, and a few minutes ago you mentioned the National Technical Information Service. Could you tell us which, if any, of these former efforts to disseminate information are still in existence? How does the individual—the homeowner, the builder—go about getting information?

Mr. TRIBBLE. Let me refer that question to Dr. San Martin. I think he is in a better position to answer that than I am. If there is anything that I can add, I will be pleased to do so.

Mr. SAN MARTIN. Mr. Fish, as you know, some of these programs—in particular, the regional solar energy centers—are no longer in existence at this time. But I would like to share with you what I think is still a very substantial information program that exists.

One of the responsibilities that Mr. Tribble has, based on laws passed by Congress, is to, on an annual basis, survey all of the energy information programs existing in the total Federal Government and report that to the Congress to insure that there is at least some level of coordination between all of the agencies that are working in this area and the work that they are doing.

In fact, there are over a dozen Federal agencies that are involved and have some energy information and energy education program of one type or another, and these range from ACTION to the Department of Agriculture, Commerce, Energy, the Tennessee Valley Authority, Transportation, et cetera, et cetera.

The latest report submitted to the Congress, that was submitted in December 1981, actually covered fiscal year 1981 and documented in that report that the Federal Government had spent approximately $368 million in energy information and education programs in these various agencies.

In fact, the largest single entity that was involved in supporting these types of activities ended up being the Assistant Secretary's programs in conservation and renewable energy. They represented over two-thirds of these various activities.

So there is a very considerable effort going on in energy information which I think we all agree is a most difficult area to address, because even though there are many conferences for exchange of information, publications available, a gigantic repository in the Technical Information Service, and so on, it does not necessarily follow that every individual might happen to know of the existence of this wealth of information and have the opportunity to utilize it, but as you know, thousands annually access these programs.

We still, for instance, maintain the Conservation and Renewable Energy Inquiry Service run for us by the Franklin Institute, where toll-free numbers are available to anyone in the country to call and request information.

Mr. FISH. What is the name of that again?

Mr. SAN MARTIN. It used to be the Solar Heating and Cooling Information Center. We have since renamed it to be the Conservation and Renewable Energy—I cannot remember the exact words, but it is an inquiry and referral service.

They receive thousands of inquiries per month, and we have been doing as good a job as we can, I believe, Mr. Chairman, in trying to disseminate the wealth of this information to anyone in the country who wants to know.

Mr. FISH. I would like to just go back over my question. I mentioned at least four prior information sources and asked you wheth-

er or not they were in existence. You said the regional solar centers are not. How about the Energy Extension Service?

Mr. TRIBBLE. Yes.

Mr. FISH. It is. The Residential Conservation Service?

Mr. TRIBBLE. Yes.

Mr. FISH. And you said the Conservation and Renewable Energy Inquiry Service has replaced the former one.

The National Technical Information Service—where does that fit in with these other three?

Mr. TRIBBLE. Let me ask Dr. Savitz to answer that.

Ms. SAVITZ. The National Technical Information Service is run by the Department of Commerce, where all reports are sent and the public can purchase them. The other one is the Technical Information Center run by Oak Ridge National Laboratory, where all technical documents are and are made available to the public on writing them. Those both exist and will continue to exist.

Mr. FISH. Mr. Tribble, when predecessors sat where you are sitting—and I remember Dr. Savitz accompanied them even then—I have been going over the same ground now since I was a young man—I said at the time that we had too many places to get information it was too confusing for the average person to know where to go.

Now I am told that, instead of having four or five places, we have a half dozen, all in separate departments. That just simply make it more difficult—instead of just one or two visible places, that could be broken down into local areas, where people would know to go. I find it very confusing to have so many different outlets rather than a major central focus.

At first I was disturbed when I heard you say you thought you had done enough research and development. Then you said that you were going to continue with research.

I guess the thing we have to do is to look at the record. Let us take 1976, the year that we really began our efforts in your jurisdiction. Could you tell us the record, in terms of energy savings, in the area we are dealing with—buildings—that, as you say in your testimony, consumes more than one-third of the Nation's energy? Could you tell me the consumption of buildings in terms of quads in 1976 and compare that with 1981?

Mr. TRIBBLE. I do not have that information with me and will have to submit it for the record.

Mr. FISH. How do we know that your program has been a success, unless the total has gone down—the absolute total?

Mr. TRIBBLE. We have data on the energy consumption per household and also on the energy consumption per square foot of a building area, and the trend is very definitely down. I do not have the numbers, but I know that the trend is down.

Mr. FISH. I think it would be very helpful if we had those figures that you know about.

Mr. TRIBBLE. Yes.

Mr. FISH. Dr. Savitz.

Ms. SAVITZ. I can give you one number: Five years prior to 1972, the rate of growth of energy use in the building sector was increasing at 3.8 percent a year. Between 1973 and 1980 that rate of growth had dropped to 0.8 percent a year, so that the rate of growth has decreased. During that time there was additional construction added.

Basically, the level of energy use by that sector has remained fairly constant since 1973, with new buildings coming in more efficient and new products coming in more efficient. So there has been growth in the area, and that new growth has been more efficient.

Mr. FISH. Finally, Mr. Tribble, you also say in your testimony, "There is great opportunity for cost-effective improvements in the efficient utilization of energy in buildings." Our testimony today seems to look to the future.

Could you tell us how, in your judgment, this committee of the Congress could be of the greatest help in fostering what we consider a very important program and one that should be aggressively pursued? How could we help in realizing the great opportunity for cost-effective improvements and efficient utilization of energy?

Mr. TRIBBLE. One of the things that I was referring to in that testimony is the fact that the inventory of buildings that we now have was largely built in a time when energy was inexpensive. We really need to come forward with some means of retrofitting the existing inventory so as to upgrade the energy efficiency. We are constantly looking for ways in which we might effect that. As we come forward with those, we will be coming to the committee asking for funding for those kinds of activities. We would welcome the suggestions of anyone, particularly those from the trade associations and the industry itself on very specific things that we could do that would in fact enable us to accomplish some of this additional efficiency.

Wherever those proposals do, we think, add to the knowledge and the ability to save energy, we would propose to you that we participate and that you fund that kind of activity for us.

Mr. FISH. I thank you for that, and I look forward to your comments.

Thank you, Mr. Chairman.

Mr. FUQUA. Thank you, Mr. Fish.

Mr. Dunn.

Mr. DUNN. Thank you, Mr. Chairman.

Dr. Tribble, you made a statement earlier that some survey you had indicated that the single most important factor in purchasing a new home today is energy.

Mr. TRIBBLE. Yes.

Mr. DUNN. In light of that statement, I would recommend canceling your budget. The single most important factor today in buying a house is interest rates.

Mr. TRIBBLE. That is right.

Mr. DUNN. Period.

I do not know where you are getting your survey data, but it is not even close to the mark.

Mr. TRIBBLE. Well, there is no question but that you are right.

Mr. DUNN. Why did you make a statement like that?

Mr. TRIBBLE. We were talking of the mechanical and heat transfer aspects and the components of the building—the characteristics of the building—not of the financing.

Mr. DUNN. This is a very impressive list you have of people interested in this building energy research program. When I checked with some of their Washington offices, I found that indeed there is an interest. When you go out in the field and talk to people, you get an entirely different story. Can you comment on that?

Mr. TRIBBLE. I am sorry—which?

Mr. DUNN. The building energy research program.

Mr. TRIBBLE. Of the proposal that has been proposed? I think you are speaking of individuals in some of the associations and so forth.

I guess I am not in a position to comment on whether or not the proposal before us does in fact represent a consensus of the organizations that participated, but I am sure the panels to follow would be able to address that question.

Mr. DUNN. So you would rather I question the panels on the rest of this program. Do you have a comment on the program or not?

Mr. TRIBBLE. I do not know of anything to add to what we have already said.

Mr. DUNN. Let me reserve the rest of my questions for the panels, Mr. Chairman. Thank you.

Mr. FUQUA. Thank you, Mr. Dunn.

Mr. Tribble, thank you very much; and you Dr. San Martin and Dr. Savitz. Thank you very much for being here with us this morning.

Mr. FUQUA. Our first panel will include John Cable of The Ehrenkrantz Group; Dr. J. Douglas Balcomb, whom we will ask our colleague Mr. Skeen to present; and Ralph Johnson, president of the National Association of Homebuilders Research Foundation.

In view of the fact that we have a vote on, we will recess briefly so that we can run and vote.

[Recess taken.]

Mr. FUQUA. I will begin by recognizing Mr. Skeen from New Mexico to present the distinguished witness from his State.

Mr. SKEEN. Thank you, Mr. Chairman.

It is a real pleasure and an honor for me to say hello and welcome Dr. Doug Balcomb, a longtime friend of mine from New Mexico, who lives in Los Alamos.

I would like to say that he has had national recognition not only as a theoretician in this field but as one who has done a great deal of work in practical applications. I believe Doug built his own home, incorporating an awful lot of new technology and new ideas in energy conservation. So I think this gentlemen knows whereof he speaks, and we are proud to have him in New Mexico.

Of course I should have said something to Dr. San Martin. In our country that is called "San Marteen." We are delighted that he too is here. So New Mexico is well represented.

Doug, welcome; we are glad to have you here.

Thank you, Mr. Chairman.

Mr. FUQUA. Thank you, Mr. Skeen.

We will begin with Mr. John Cable.

[The biographical sketch of John Cable follows:]

BIOGRAPHICAL SKETCH

JOHN HART CABLE, AIA

Director of Research and Technical Services, The Ehrenkrantz Group

Experience

John Cable directs the activities of the Washington, D.C. office of The Ehrenkrantz Group in the area of energy-sensitive design and development. Mr. Cable is the former director of the Buildings Division of the U.S. Department of Energy (DOE).

With the DOE, Mr. Cable created and directed a research program addressing energy efficiency in buildings. The project achieved major technical advances in the areas of daylighting, window design, envelope systems, thermal mass, insulation, energy estimating, ventilation and indoor air quality, air infiltration, energy auditing and building diagnostics. These advances provide the technical basis for designing buildings to be 50 percent more energy-efficient than allowed by normal practices of the late 1970's.

Mr. Cable also assumed responsibility for the technical formulation and development of the country's first nationwide building energy performance standards during his tenure at the Department of Energy. The program established the base line of existing energy design levels for 22 building types in 32 climates and involved 1,600 commercial and 120,000 residential buildings. Mr. Cable redirected the program to produce voluntary guidelines and actual data for designers rather than mandatory standards.

As principal of his own practice, captain of a Base Civil Engineering Office of the U.S. Air Force and an associate or member of several architectural and planning firms, Mr. Cable planned, programmed, designed and managed construction of single- and multi-family housing buildings.

At The Ehrenkrantz Group, John Hart Cable applies his knowledge of energy conservation technology, practices and policy to the planning and design of new development and the adaption of exising structures to energy-efficient operation.

Education

Catholic University, Master of Architecture
Clemson University, Bachelor of Architecture

Citations

Citation as nominee for Engineering News Record Man of the Year Award
Commendation for Improving Energy Efficiency of the Buildings Sector, DOE
International Energy Association 1981 Conference, Berlin, Chairman of Building Industry portion of program

Registration

South Carolina, NCARB

SUPPLEMENTAL INFORMATION -CABLE

Recognized as an international authority on energy efficient building design -

- Chaired IEA's Buildings Sector portion of the Berlin "Conference on New Energy Conservation Technologies & Their Commercialization" April, 1981
- Represented the U.S. Department of Energy as a member of the I.E.A's executive committee on Buildings and community systems
- DOE's representative to the National Academy of Science's International CIB-W67 "Energy Conservation in Buildings"

Member of American Institute of Architects National Energy Committee

Member of ASHRAE

Cited in 1980 by McGraw Hill's Engineering News Record "from among the many who serve in the best interests of the construction industry"

Technical advisor to the New York State Energy Research and Development Authority for their project on "Daylighting Technology Evaluation".

STATEMENT OF JOHN CABLE, THE EHRENKRANTZ GROUP, WASHINGTON, D.C.

Mr. CABLE. Thank you, Mr. Chairman and gentlemen.

I am John Cable, a principal of the Ehrenkrantz Group, an architectural firm located in New York; Washington, D.C.; San Francisco, Calif.; and Nashville, Tenn. You should know that my background includes several years of construction work and as a licensed architect prior to my former job as division director in the conservation program at DOE, which I left earlier this year.

I will address the issues that you set forth in your letter of invitation in the order you presented them.

On the question of the proposed reorganization, I cannot strongly enough endorse that. It is long overdue; and I have to, with all due respect, take exception to some things you have heard already. I do not personally believe, having been at the working level, that that reorganization can be effective if it does not occur at much lower than the Assistant Secretary level in the program.

I think the technical staffs, no matter how well intended they are--and they all basically are, as you know—have to answer to the tune of the drummer they work for. The first thing that goes out the door when you are under intense pressure, as they all are because they are understaffed, is coordination with your counterpart that you would like to coordinate with.

So my suggestion is, very simply, that I strongly endorse the concept of an integrated program, and I would submit my own opinion that it must happen at a level much below the Assistant Secretary.

On the second point, which is the merit of the research agenda that has been proposed, this is a difficult issue for me to deal with, in that I have been so intimately involved in the program for a number of years, so I have tried to stand back and look at it in an arms-length mode. What I would say is both good and bad about the proposal.

Again, the concept of an integrated approach is a sound one. When you look at those technical skills which are necessary to formulate and direct a sound research program, you find that they do not slice up by solar and conservation. You need to have people with expertise in various aspects of building energy sciences, and engineering.

However, I would challenge many of the elements that have been proposed as the basis of a research program. What I would like to do is review the points listed in the proposal, and part of my opinion about each of them will come out.

The first one, again, where buildings should be treated as integrated and dynamic energy-using systems—certainly this has to be supported and endorsed. The point is that it is not an either/or question. Energy efficiency is approached from looking at how individual components function, and it is also achieved by looking at how those individual components interact with one another. It is that interaction under which substantial gains are yet to be achieved.

The second point, which says the research program should be based upon the actual behavior of occupied buildings—I would re-

spectfully submit that the authors are simply naive. The programs are based on that. There is an extensive amount of data there.

That is not to say that more information is not useful, because it is, but the computer programs are written based on a detailed knowledge of the engineering assumptions involved, and then the first thing you do once you write the program is go and test it and find out how it works against real buildings and against lab experiments. So I think that is just a misunderstanding on the part of the authors.

The next point of residential and commercial buildings should be treated separately—I would disagree with that on the face of it, but not in some detail of how building research programs are organized. There is absolutely no question that the industry that designs and builds single-family detached and townhouse-type structures is quite different than our industry that builds buildings such as the one we are in office buildings, hospitals, schools, et cetera.

But, in a fundamental energy phenomenon research program, where you are looking at the basic R&D activities, you are not looking at building types; you are looking at heat transfer, ventilation, indoor air quality, lighting, et cetera—issues which you have heard many times—and they must be explored on a technical level independent of building type.

I also think that in an applied area—and we all use the terms "basic" and "applied" in different ways, so that is one of the definitional problems, I think. In an applied area, of course it is absolutely imperative to then look at programs according to various building types.

I would offer the caution however, it has been my experience that in a bureaucracy you can handle that kind of difference by the program managers—having a program manager for a certain group of buildings and another program manager for a certain group of buildings. You certainly do not have to have an organizational structure that goes up through branch chiefs, division directors and office directors as being a whole functional unit for commercial buildings and a whole unit for residential buildings. I think that would be a very wasteful way to go. It would introduce a level of duplication not necessary to implement sound, lean programs.

The fourth point—a research program should be oriented toward the specific needs of those who will apply the research results; namely, homebuilders, architects, engineers, appliance and product manufacturers, retrofitters, building owners, and occupants—I think that entire question could be time consuming and take up the entire morning. I think it is a misconceived question.

The research that is currently being done and has been done for years has been aimed at understanding the technical issues. I do not think anybody with intimate knowledge of the programs would argue the fact that various types of dissemination were effective or were not effective and that more cannot be done in how the research groups interrelate with other parts of the community.

But certainly the basic driving purpose of any of the work that has been done is specifically for the people they say it ought to be for.

I would like to hold up an example which you have heard about and you will hear a lot more about. It is simply the program plan that has the title, "The Thermal Performance Of Building Envelope Systems And Materials" [indicating book].

Yes, I am biased. I had a lot to do with with organizing this. But I want to tell you why I think it is a valid model for you to look at. That program plan evolved over a multiyear period. We started it in, I think it was in 1977—the late 1970's. It reflects the participation of private industry, manufacturers, Government, and universities. It is a program plan that definitely identifies a specific direction in a technical area. It is not a plan that the Government intends to sponsor by itself; it is one that can be used to work cooperatively with private industry. Much of the work that is cited in there is not even contemplated to be done by the Government; it is work that is expected to be done by various segments of the private sector.

I think you will hear testimony later today from a gentleman who can say a lot more about the details of the plan, if you should like, but I want to underscore one point, and that is that, as a model for a program plan, it is a good one in that it has reflected intense participation of a broad representative sector of our community over a multiyear period. It has not been a plan conceived of by any one group sitting in a corner. Therefore I think it is a very effective and soundly based one. Illustrating the best of cooperative efforts between the private sector and Federal Government research.

The fifth point—the research program is balanced between near- and long-term development work—one of the problems with Government-sponsored programs is that by the time it is formulated, submitted to Congress, funded, and activities are started, you are already talking about a multiyear timeframe. I am not really sure there is any such thing as a short-term Government activity.

Certainly I agree with the point that we cannot focus exclusively on long term, 20-year-away timeframes.

I would cite to you that there have been numerous examples—since the programs were organized in 1976 and 1977, there have been numerous substantive advances, and I think that is a very credible point you should not lose sight of.

The last point—No. 6—an ongoing component of the program should be research into health and safety aspects of building energy—I say of course.

One has to be intelligent about recommended changes to procedures and look in a holistic manner at the implications that they will have in other aspects of the building, and that gets to one of my earlier points, which is, research must be done on an integrated systems basis.

Let us discuss just briefly now what research might be appropriate for the Federal Government to undertake. Again, the presentation that we were asked to comment on lacks so much specificity that it is not reasonable to go down each bullet point of it and debate the issue, but I would discuss my own views about the types of things that are appropriate.

We have heard that the building sector is highly decentralized, but I want to drive that point home. It is not only highly decentral-

ized; you could characterize it as local and small. There are a few large corporate manufacturers that manufacture certain kinds of products, but the people that design, the people that build, and the people that finance these buildings come to you from your local town level.

These statistics are conceptually correct; I would not stand behind them to the decimal point, but something like 75 percent of all the homebuilders in the United States build fewer than 25 units of housing a year. It is less than 1 percent of them that build over 500 units a year.

In terms of architecture and engineering, the average architectural or engineering office in the United States has 2.5 professionals in it. Seventy-seven percent of all the firms employ fewer than 25 people.

Gentlemen, the points I am trying to stress for you are simply that the people that have to have the knowledge and understand how to design, how to put together, how to assemble buildings, are small businesses by and large. They do not as individuals, and they do not through their professional affiliations have the kind of financial resources it takes to do a fundamentally sound building energy research program.

I would like to stress another point that has come out in the last couple of years, and that is the issue that you do not do product-related research because that is the research that the private sector does do.

It has been our experience that the majority of research that they do on product-related activities is driven by many, many different issues other than energy, and energy is normally incidental to their prime one, which is marketing a product. A lot of things they call product R&D are in fact marketing and cosmetic R&D; they are not substantive technical changes, the point there being that much of the presentation about how much money industry might spend for research, one has to look at that very, very carefully in terms of how much of it is going to advance the state of the art.

What I am trying to illustrate by those statements is very simple: There is a desperate need for a fundamentally sound, Government-sponsored research program. It should be organized in a manner to be supplemental to the private sector, and I think the program plan that you have is an example of how the plan reflects that intercooperation.

And it must be recognized that the Government can act as a catalyst and focus a lot of untapped energies and talents in this country, and that is the type of thing that integrated planning allows you to do.

I would like to address, without getting into specific numbers, a fundamental concept, and that is, how big does the program have to be? I do not think it has to be large. I would agree in concept with the statement that is included in your proposal, that at the level of the consolidated budget you can manage a sound program. I believe that is true.

Along the lines of budget, I would offer you something that I realize is a pipedream, but nonetheless it should be an objective that we strive to achieve.

If you think about the people that try to implement the funding that is available, the worst thing that can happen is massive budget oscillations. A budget that is $5 million one day, then $20 the next, and then down to $2 million is so counterproductive and so destructive that very little gets done except in overtime, because everybody spends their time trying to fight to keep their budget.

I would respectfully suggest, within the limits of possibility, that we consider a budget level that is reasonable and not so large that it is going to constantly be attacked, but then try very hard to keep it over a multiyear period, so that the technical staff knows what is coming, they can plan for it, they can organize for it, and they can do an extremely superior job on your behalf.

I would also like to say one other thing in closing, and that is that we hear all types of success stories about the fact that we now know how to design energy-efficient buildings, and those are true stories. Our firm is designing a 900,000-square-foot building for the Social Security Administration, with an energy budget of 43 MBtu per square foot per year, and that is very good. We think by the time it hits construction the budget will be lower than that.

There are several very talented firms around the country that strive to do energy-efficient projects. They are exemplary; they are not the mainstream. The average building that gets designed and built, although improving, has a long way to go in terms of what its potential to be energy-efficient in a cost-effective way is. We are just scratching the surface of the kinds of innovation that can occur in truly efficient building design. It is a long-term, multiyear activity.

Thank you very much.

Mr. FUQUA. Thank you very much, Mr. Cable.

Dr. Balcomb.

STATEMENT OF J. DOUGLAS BALCOMB, LOS ALAMOS NATIONAL LABORATORY, LOS ALAMOS, N. MEX.

Mr. BALCOMB. Thank you very much for asking me to testify, Mr. Chairman.

I have given you written testimony which addresses the two questions that you proposed: First, comments on the proposal for a building energy research program; and, second, recommendations on research and development activities. I am not going to attempt to read through all of that written testimony.

Mr. FUQUA. Without objection, we will make the statement in its entirety a part of the record, and if you wish to summarize, please do so.

Mr. BALCOMB. Thank you.

I will just pick up on some of the key points that have been addressed in my statement and add one thing that I feel has come out of the comments made so far.

First, I want to indicate my support for the proposal to combine DOE's building energy research activities into one coordinated effort. Although I do not agree with some specifics, the general concept has the potential for a more concerted and better focused program.

I believe that building energy research is essential and that it is important that it be funded by the Government. As a participant in the passive solar program for the last 7 years, I have experienced the problems that have developed due to the division of DOE program management between the conservation and solar efforts. Although lip service was given to close coordination, the result has been far less than satisfactory.

The second point is that I especially welcome the change in character that the administration has brought to the solar program. Research is no longer a forbidden word. The program proposal speaks very eloquently to the need for a federally sponsored building energy research program, and the key emphasis should be on research.

The research should be driven by considerations of the marketplace, and I agree that industrial representatives should participate in program direction.

The emphasis should be on approaches that work rather than highly speculative and exotic, untried concepts. They must work not only thermally but must also be economical and acceptable in the marketplace.

I find three defects in the proposal as submitted. I find that it places extreme emphasis on empirical data from monitored buildings. Although I, of all people, certainly agree that research must be rooted firmly in the reality of actual experience, a single-minded empirical approach is both unscientific and inappropriate. A broad-based program is needed.

I find that a missing ingredient in the proposal is a core of systems analysis to provide overall direction to the program, that is, a guiding light.

One emphasis of the proposal that seems inappropriate is the insistence on treating different building types differently. This is carried to the extreme of proposing four separate programs divided according to building type. This would be very inefficient and wasteful of resources, because it would create many overlaps and jurisdictional problems.

I do agree that a separation by building type is very important when considering the end use of the research, such as the development of design tools, but we need to move toward a more coordinated and consolidated program, not toward another artificial and inappropriate disaggregation.

One concern that must be addressed in any reorganization is to be sure that all promising solar technologies have an appropriate home. Where will active solar ponds be located? Will the proposed new buildings research organization be so dominated by conservation that important solar opportunities are lost?

Remember that we are working on technology development, and other aspects of solar have things to offer. Researchers have proved that they are competent to locate energy needs and to work on them.

The second part of my remarks deals with research tasks that I feel should be part of such a program. I think the fundamental underlying problem is that building climatology has not been undertaken as a science in this country. We have developed a technology

gap in building energy research, and many other countries are ahead of us in this field right at this time.

I submit that this Nation needs a long-term, scientifically based national program effort in building climatology. Such a program would focus research toward understanding energy flow in buildings, including a study of the quality of the environment and the effect on human beings.

A major thrust of this program would be to identify research needs and administer programs aimed toward the development of new materials and techniques that would reduce energy use in buildings while enhancing the quality of life inside. The approach would be to buildup centers of specialized expertise in the various aspects of building climatology. A total of six to eight such centers is needed, each staffed by 10 to 20 professionals, each located in national or private laboratories or in universities. The total level of funding would not be large, but it is important that it be sustained over a long period at a reasonable level rather than go through boom and bust variations that preclude the aggregation of good scientific research personnel, facilities, and equipment.

The goal is nothing less than to elevate the field of building climatology from its fragmented and disjointed pieces into a powerful scientific discipline responsive to national needs.

As a start in this direction, a small group of us identified 50 tasks which might be part of such a program. A list of the people who worked on this is enclosed with your handout on page 7. You will see that it is a very broad and very knowledgeable group.

An outline of the task categories and a brief scope statement of the tasks are enclosed in your handout. The group discussed the pros and cons of the tasks at length. Los Alamos analyzed how much additional energy could be saved in the various climates if the research goals were to be met.

For many of the proposed tasks, energy savings could be doubled. The implication of this is that passive solar would be as cost effective in cloudy climates as it now is in sunny climates. Thermal comfort and flexibility of design would also be improved.

For each proposed task, the group studied the potential for improved energy savings, the potential for improved cost effectiveness, practicality for use, success potential of the proposed research, potential for application on retrofits, appropriateness for Government funding, and then rank ordered the tasks. The results are shown on pages 9 and 10 of your handout.

Although this process has not led to a detailed recommendation for a program structure, it clearly indicates the tasks that should receive emphasis.

What emerges is a clear picture that much research remains to be done and that much energy can be saved by its successful completion. The key issue is the management of the research effort. To be productive, researchers need to work in an appropriate environment, preferably as a team. This team needs stability in both planning and funding in order to attract and hold good people. Goals should be well defined and freedom allowed to search out innovative approaches to achieve these goals. Adequate equipment must be available.

The problems that we are dealing with have been with us for a long time and will yield better to a steady pressure than to a crash effort.

Peer review of the involvement of the participants and program direction is essential to good research. Each research group should have a well defined area of expertise and should not feel constantly threatened. Scientific exchange should be encouraged. Management should be supportive and not interfere with the day-to-day progress of the work.

The last point that I would like to have you understand is the important link between building energy research and jobs in this country. We have two key problems:

As I see it, our buildings use too much energy and are costing too much to heat, and our building industry is in a depression. Why not put these problems together and create a solution? Why pour money into fuel when less money could be directed into the building industry all across the country?

We need to renovate these buildings. This would stimulate jobs, help small business, and leave us with a viable building stock.

Why is building energy research important to achieving this? For two reasons: First, generic research on materials will lead to much improved products being developed by industry. Second, research leads to credibility, and credibility, both in the building industry and in the marketplace, is important if people are to actually invest in building renovation.

Building energy research is probably the most cost-effective way to achieve the results and is completely consistent with the appropriate Government role.

Thank you.

[The prepared statement of Dr. Balcomb follows:]

Testimony to the:

Committee on Science and Technology
Energy Development and Applications Subcommittee
U.S. House of Representatives

hearing on

BUILDING ENERGY RESEARCH

July 22, 1982

by

Dr. J. Douglas Balcomb
Scientific Advisor, Solar Energy Group
Los Alamos National Laboratory
Los Alamos, New Mexico 87545

I. COMMENTS ON PROPOSAL: "THE BUILDING ENERGY RESEARCH PROGRAM"

II. RECOMMENDATIONS ON RESEARCH AND DEVELOPMENT ACTIVITIES

I. COMMENTS ON PROPOSAL: "THE BUILDING ENERGY RESEARCH PROGRAM"

In concept, the proposal to consolidate the building conservation and solar programs is sound. Although I do not agree with some specifics of the proposal, the general concept has the potential for a more concerted and better focused program. I believe that building energy research is essential and that it is important that it be funded by the government.

As a participant in the passive solar program for the last seven years, I have experienced the problems that have developed due to the division of DOE program management between the conservation and solar programs. Although lip service was given to close coordination, the result has been less than satisfactory. I have been especially concerned that the Buildings and Community Systems branch has largely ignored the potentials of cost-effective passive solar approaches and the need to integrate these with conservation. It is important to appreciate that the marketplace leads in this field, and the role of the research program is to provide sound information on the effectiveness of all options rather than adopt an advocacy position regarding one or another approach. I do believe that the solar technologies should maintain their discrete name identification and budget in a future consolidated organization lest they be swallowed and ignored further by the conservation group.

I have especially welcomed the change in character that the administration has brought to the solar program. Research is no longer a forbidden word. The previous commericialization-oriented program proved once again that the government is inept at commercialization; the adverse side effects of most of the efforts were at least as pronounced as the benefits. The costs to the government were so high that most of the research funds were co-opted for commercialization. I hope that the proposal presented is not an attempt to resurrect the end-use emphasis of the program as the proposal might be construed to advocate. The proposed funding levels could not support it.

The program emphasis should be on building energy research. I especially concur with the statement in the proposal, that

> "... a federally-supported energy use research program is needed. The building industry is decentralized, predominantly made up of many

> small-to-medium-sized firms involved in building construction or in the distribution of systems and components that go into buildings. This makes it very difficult for the industry to undertake a comprehensive energy research program. Building users are likewise very diverse, including major public and private institutions, small businesses, and individual owners and renters of single family homes and apartments. A coordinated federal research program is essential to address this wide range of interests in a meaningful way and to continue the nation's progress toward real energy efficiency in buildings."

The research should be driven by considerations of the marketplace, and I agree that industrial representatives should participate in program direction. The emphasis should be on approaches that work rather than on highly speculative and exotic untried concepts. They must not only work thermally, but must also be economical and acceptable in the marketplace. Emphasis should be placed on building design rather than on gadgets although generic research on components, such as glazing, is certainly appropriate because the potential for energy savings is so great.

The proposal places extreme emphasis on empirical data from monitored buildings. Although I, of all people, certainly agree that research must be rooted firmly in the reality of actual experience, a single-minded empirical approach is both unscientific and inappropriate. One must first understand the physics of energy flow in buildings and here data from monitored buildings are essential. The subsequent computer analysis of buildings, based on actual weather data, is a proven and powerful tool essential to achieving the overall goals. The program should strike a balance between gathering data from experiments, test modules, and monitored buildings; reporting of these data; development of analytical models; validation of the models; the use of computer programs based on these models for systematic study of a variety of design approaches to a variety of building types in a variety of climates; development of simplified analytical methods and design tools; and research on materials and components.

A missing ingredient of the proposal is a core of systems analysis to provide overall direction to the program, to serve as a guiding light. This work is essential for estimating the impact of any proposed research task. Too often we have seen ideas pursued based on a false perception that a

particular result would lead to a pronounced performance improvement when a little preparatory investigation would have showed otherwise. Systems analysis is also essential to achieving effective utilization of research results.

Another emphasis of the proposal that seems inappropriate is the insistence on treating different building types differently. This is carried to the extreme of proposing four separate programs divided according to building type. This would be very inefficient and wasteful of resources because it would create many overlaps and jurisdictional problems. A few examples: (1) if a better glazing is developed, it will be useful for all buildings; (2) study of natural convective heat exchange in a building is almost independent of building type and so is the study of infiltration; (3) a passive solar element will deliver about the same amount of heat to a commercial building as to a residence. I do agree that a separation by building type is very important when considering the end use of the research, such as the development of design tools. But we need to move toward a more coordinated and consolidated program, not toward another artificial and inappropriate disaggregation.

One concern that must be addressed in any reorganization is to be sure that all promising solar technologies have an appropriate home. Where will active solar and solar ponds be located? Will the proposed new buildings research organization be so dominated by conservation that important solar opportunities are lost? Remember that we are working on technology development and that other aspects of solar have things to offer. Researchers have proved that they are competent to locate energy needs and to work on them.

In conclusion, I support the proposal subject to the comments I have made. I am optimistic that this effort will bring coherent direction to the work and increase effectiveness.

II. RECOMMENDATIONS ON RESEARCH AND DEVELOPMENT ACTIVITIES

We are all aware that energy use in buildings is incredibly wasteful. That huge savings can be made by relatively simple means is well documented.

It is rather amazing that the United States, a country dedicated to technology, got into such a mess.

I have one specific proposal and the results of a rather interesting evaluation of building research needs to offer by way of recommendations.

Building Climatology

I think a fundamental underlying problem is that building climatology has not been undertaken as a science. Building science and architectural engineering have become concerned primarily with structures and with mechanical systems. That such eminently simple techniques as superinsulation, passive solar heating, daylighting, and natural cooling were ignored is sufficient testimony to the fact that a near vacuum has existed in the field of building climatology. The need for a national program focus in this area existed 50 years ago and it exists to an even greater extent today.

I submit that the nation needs a long-term, scientifically based national program effort in building climatology. Such a program would focus research toward understanding energy flow in buildings, including a study of the quality of environment and the effects on human beings.

A major thrust of this program would be to identify research needs and administer programs aimed toward the development of new materials and techniques that would reduce energy use in buildings while enhancing the quality of life inside. The approach would be to build up centers of specialized expertise in the various aspects of building climatology. A total of 6 to 8 such centers is needed, each staffed with 10 to 20 professionals, each located in national or private laboratories or in universities. The total level of funding would not be large, but it is important that it be sustained over a long period at a reasonable level rather than go through boom and bust variations that preclude the aggregation of good scientific research personnel, facilities, and equipment. The goal is nothing less than to build up the field of building climatology from its fragmented and disjointed pieces into a powerful scientific discipline responsive to national needs.

Building Research Needs

With a shift in the passive solar program thrust toward research, it became evident that careful thought should be given to analysis of promising new research directions. A small ad-hoc committee was brought together for

this purpose consisting of members all very knowledgeable in various aspects of building and material science coming from various appropriate institutions and representing a variety of professions. A list of the members is attached.

The committee has proposed and discussed a variety of potential tasks that might fit into a future research program. The emphasis has been primarily on passive solar, natural cooling, and daylighting approaches although some related areas of building climatology also have been included. Eventually 35 research tasks and 15 supporting tasks were identified. An outline of the task categories and brief task scope statements of each are enclosed. The committee discussed the pros and cons of the tasks at length. Los Alamos analyzed how much additional energy could be saved in various climates if the research goals were to be met. For many of the proposed tasks, energy savings could be doubled. The implication of this is that passive solar would be as cost effective in cloudy climates as it now is in sunny climates. Thermal comfort and flexibility of design would also be improved.

Committee members then scored each research task according to a set of criteria that included the following:

Potential for improved energy savings
Potential for improved cost effectiveness
Practicality for use
Success potential of proposed research
Potential for application on retrofits
Potential for use in non-solar applications
Appropriateness for government funding
Overall merit

Supporting tasks were scored according to different criteria:

Importance to guiding the research effort
Importance to achieving utilization of research results
Appropriateness for government funding
Overall merit

A composite score was developed for each task, computed as an appropriate mix of the individual scores for each of the separate criteria; the tasks were then rank-ordered according to this composite score. Graphs showing the group-average scores and also a listing of the rank-ordered tasks are enclosed.

Although this process has not led to a detailed recommendation for a program structure, it clearly indicates the key tasks that should receive

emphasis. What emerges is a clear picture that much research remains to be done and that much energy can be saved by its successful completion. It should be emphasized that the supporting tasks are essential to program success; they are important both to guiding the research effort and to effective utilization of the research results.

Research Management

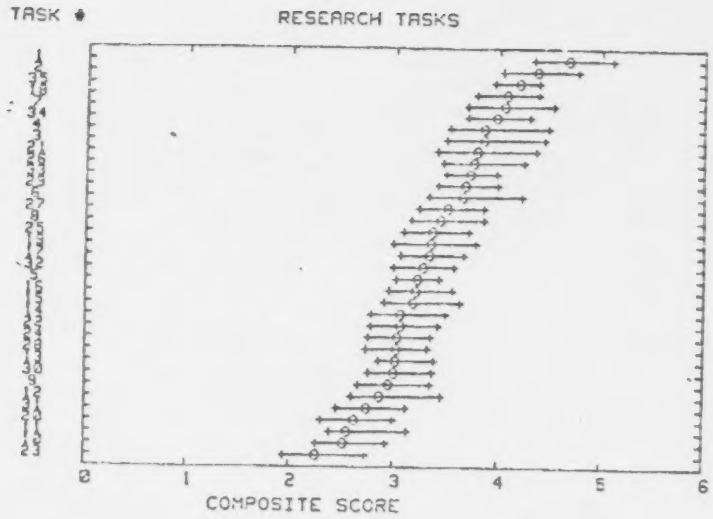
A key issue is the management of the research effort. To be productive, researchers need to work in an appropriate environment, preferably as a team. This team needs stability in both planning and funding in order to attract and hold good people. Goals should be well defined and freedom allowed to search out innovative approaches to achieve those goals. Adequate equipment must be available. The problems we are dealing with have been with us for a long time and will yield better to steady pressure than to a crash effort. Peer review and the involvement of the participants in program direction are essential to good research. Each research group should have a well defined area of expertise and should not feel constantly threatened. Scientific exchange should be encouraged. Management should be supportive and not interfere with the day-to-day progress of the work.

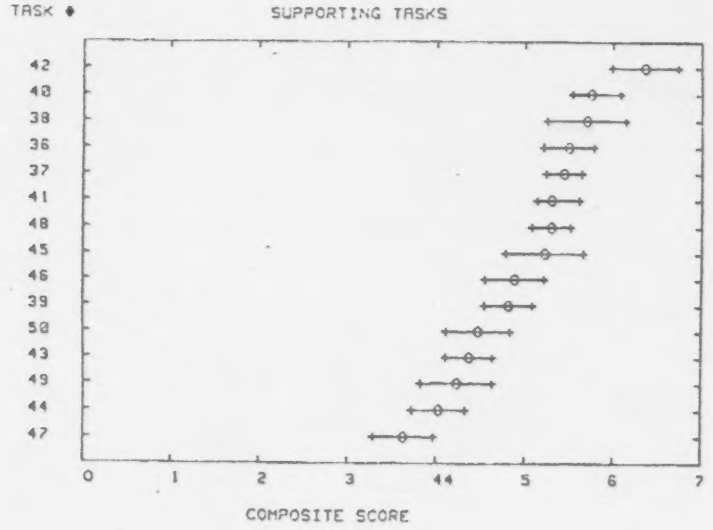
PARTICIPANTS IN RESEARCH PROGRAM COMMITTEE

J. Marx Ayers	Ayers Associates	Engineer, Building energy management
J. Douglas Balcomb	Los Alamos National Laboratory	Engineer, Passive heating research
David Bensen	Solar Energy Research Institute	Engineer, Heat transfer
Mark Bohn	Solar Energy Research Institute	Engineer, Heat transfer
Peter Calthorpe	Vander Ryn and Calthorpe	Architect, Passive heating and cooling
Roland Goldner	Tufts University	Physicist, Optics and glazings
Bruce Hunn	Los Alamos National Laboratory	Engineer, Commercial building design tools
Ralph Johnson	National Association of Home Builders	Director, NAHB Research Foundation
Timothy E. Johnson	Massachusetts Institute of Technology	Architect, Glazings, direct gain design
Carl Lampert	Lawrence Berkeley Laboratory	Physicist, Optics, glazings, coatings
Donald A. Neeper	Los Alamos National Laboratory	Physicist, Solar heating and cooling
Steve Selkowitz	Lawrence Berkeley Laboratory	Physicist, Windows and daylighting
Robert Sonderegger	Lawrence Berkeley Laboratory	Physicist, Building energy flow
Donald Watson	Yale University	Architect, Solar buildings

PROGRAM TASK CATEGORIES

RESEARCH TASKS		TASK NUMBERS
I.	Apertures	
IA.	Selective, antireflective, and controllable glazings	1,2,3,4, 5,6
IB.	Low convection loss glazings	7,8,9
IC.	Window and window management systems	
II.	Exterior Wall Treatments	
IIA.	Enhanced collection or rejection characteristics	10,11,12
IIB.	Reduced heat flow	13,14
III.	Heat Storage and Distribution	
IIIA.	Heat storage	15,16,17,18
IIIB.	Convective air distribution	19,20,21,22,23
IIIC.	Heat transport other than air distribution	24,25
IIID.	Cooling	26,27,28
IIIE.	Dehumidification	29
IIIF.	Characteristics of indoor-outdoor spaces	30
IV.	Air Quality and Controls	
IVA.	Indoor air quality	31,32
IVB.	Sensors	33
IVC.	Controls	34,35
SUPPORTING TASKS		
V.	Modeling and Systems Analysis	
VA.	Climate data	36,37
VB.	Model development and validation	38,39
VC.	Design tool development	40,41
VD.	Systems analysis	42
VE.	Comfort characterization	43,44
VI.	Performance Monitoring and Evaluation	
VIA.	Class A	45
VIB.	Class B	46
VIC.	Class C	47
VID.	Simplified monitoring	48
VIE.	Component monitoring	49,50


TASK #
RESEARCH TASKS
0
1
2
3
4
5
6
COMPOSITE SCORE


TASK #
SUPPORTING TASKS
42
40
38
36
37
41
48
45
46
39
50
43
49
44
47
0
1
2
3
4
5
6
7
COMPOSITE SCORE

PRIORITY RANK ORDERING OF PROGRAM TASKS

Task	Research Tasks
1	Improved Selective Filters
2	Antireflective Surfaces
35	Daylighting Controls
18	Heat Storage Effectiveness Determination
7	Movable Insulation Characterization
34	Thermal Controls
4	Angle Selective Glazing
3	Coatings with Switchable Characteristics
21	Space-to-Space Convection
26	Ventilation
33	Sensors
29	Dehumidification
6	Evacuated Glazings
27	Evaporation
8	Low Loss Window Sash and Frame
25	Heat Pump Systems
19	Convective Heat Transfer Determination
17	PCM Containerization
32	Pollutant Cleanup/Dilution
5	Convection Suppression in Glazings
16	PCM Materials
15	Enhanced Thermal Storage Architectural Finish Materials
14	Infiltration Characterization
22	Stratification Effects
24	Vapor-Phase Transport Systems
28	Earth Coupling
13	High R-Value Materials
30	Indoor-Outdoor Space Characteristics
9	Daylight Control
12	Selective Emitters
31	Pollutant Source Reduction
20	Enhanced Convective Heat Transfer
11	Reduced Outside Film Coefficient
10	Walls with Thermal Diode Characteristics
23	Double-Envelope Configurations

Task	Supporting Tasks
42	Systems Analysis
40	Thermal Design Tools
38	Thermal Models
36	Climate Data Collection and Assimilation
37	Climate Data Distillation and Presentation
41	Daylighting Design Tools
48	Simplified Monitoring
45	Class A Performance Monitoring
46	Class B Performance Monitoring
39	Daylighting Models
50	Wall Performance Monitoring
43	Thermal Comfort
49	Monitoring of Apertures
44	Visual Comfort
47	Class C Performance Monitoring

Mr. FUQUA. Thank you very much, Dr. Balcomb.
Mr. Johnson.

STATEMENT OF RALPH J. JOHNSON, PRESIDENT, NAHB RESEARCH FOUNDATION, ROCKVILLE, MD., ACCOMPANIED BY JOE McGUIRE, DIRECTOR OF REGULATORY AFFAIRS

Mr. JOHNSON. Mr. Chairman, my name is Ralph Johnson, and I am president of the NAHB Research Foundation, Inc., a not-for-profit subsidiary of the 111,000-member National Association of Home Builders. In normal times they employ 3 million workers. Would that it was normal today.

With me today is Joe McGuire, director of regulatory affairs for NAHB.

I have prepared a rather lengthy statement which, if I may, I would like to have submitted for the record, along with an appendix. I would like to, in a few minutes, try to highlight some of the points therein.

Mr. FUQUA. Without objection, your full statement will be included in the record.

Mr. JOHNSON. I do appreciate the opportunity to appear before the subcommittee and to present my views on the building energy research program and on the specific recommendations posed on research and development activities that should be supported by the Department of Energy pertaining to building energy conservation and passive and active solar programs over the next few years.

While we are very greatly concerned with energy conservation and the practical application of passive and active solar techniques, we are most concerned about making homes affordable. Today's disastrously high interest rates make affordability a particularly crucial problem, and this is directly related to much of what I will have to say later.

My next comment dealing with an NAHB Economics Department survey is what Mr. Tribble referred to. He did not quite have it in context, I think. Owners of new homes were asked what features they would like to have in a future home if they were to buy it, and of that group four out of five buyers said that they wanted energy efficiency. In that context, interest rates dropped out. It was not part of the question. But there is no question but what interest rates are a key factor.

It is clear to us that the buyer's motivation and thus the builder's is the bottom line: How much does it cost to heat and cool on an annual basis? This is a critical question.

A recent SERI study stated that:

> The proper design and application of passive technology, in combination with active, photovoltaic, and energy conservation technologies, could reduce U.S. building energy consumption by more than 50 percent or 17 quads annually by the year 2000.

I believe this is quite optimistic, unless we get significant reductions in interest rates and create a climate for improving the formation of private investment capital. Surely also that projection depends heavily on national public policies and actions, and particularly I think in this key area that you are addressing today with your committee, Mr. Chairman.

Research to develop affordable end-use applications of conservation and active and passive solar techniques we think is the key. Even if the savings are only half the SERI estimate, that would translate into 8 million barrels of oil per day—at a seasonal efficiency of 50 percent—that we would not need to import. This is just a stupendous accomplishment. Given other conservation measures in transportation and industry, that just might be enough to make this Nation independent of foreign oil, and I am particularly happy that your committee is addressing this subject so thoroughly.

The homebuilding industry is an industry of small businessmen. Mr. Cable mentioned that typically in a good year NAHB's members build about 20 to 25 homes a year. Today I suspect that they are not building an average of more than 10, because the industry is in this terrible slump.

Of course, this gives home buyers a wide choice, but the disadvantage is that these small businessmen cannot afford, because their customers cannot afford, hundreds of thousands of small, unrelated research programs, and the same, I would submit, is even much more true for the solar industry.

I have set forth in the statement a number of reasons why I think this is so, and I will not repeat them. They are practical and obvious, and I am sure you are aware of them.

The very nature of the homebuilding industry is one of high risk, made even higher by the yo-yoing of interest rates through the manipulation of the Federal Reserve Board, seven times, believe it or not, I find in the last 10 years. That alone saps the strength of the industry and precludes any significant contribution dollarwise, for example, in their own research programs.

But very few builders have the inclination or financial ability to undertake the risk of experimenting with unproven products, systems designs, and technologies that may have seemed promising in small-scale laboratory studies but are unproven by research in actual homes.

Mr. Chairman, when I appeared before the subcommittee last March, I indicated support for the building energy research program concept. I did qualify that support by saying the program had much merit if structured properly, has the right goals and is designed to undertake projects that reflect the needs and energy problems of the building industry and the people it serves. I also said that the program should be much more end-use application oriented, should be screened at the concept stage and while ongoing to obtain industry input. More importantly, I said it should reflect an understanding of the building process.

I still support the program with the same provisos. I will not go into specific details on it. It was developed by a large committee of people representing widely diverse views, and obviously, like any committee program, it has a lot of give and take therein.

I believe the industry and the consumer groups that developed the program thought that there was a need for the Department of Energy's conservation programs to be more closely coordinated with a passive and active solar program and attuned to the needs of the industry as, generally, has been done so well in the passive and hybrid heating and cooling systems programs. We had hoped

that such a program would help to focus on practical applications of homes and buildings.

The letter of invitation to appear before you indicated an interpretation of the building energy research program statement pertaining to reorganization that we, at least, did not intend. It is fair to say that the home building industry is for the integration but not necessarily the combination of the conservation and the solar programs.

What we mean by integration of these programs is not a type of reorganization, administrative consolidation, or reassignment of responsibility, but a close and continuing cooperation of program management manifested in a planning process which, with active industry input, produces integrated annual operating plans.

Furthermore, I believe it is very important to provide in that program for formal liaison and coordination with HUD. HUD is the housing and urban development agency of this country. They are very experienced in the field of housing and buildings and I believe could make a contribution.

I advocate, if you are going to appropriate funds for this purpose, providing some research funds to be transferred to HUD, especially for some full-scale applications research and information packaging and dissemination. I think they have a clear understanding of what needs to be done.

In short, I believe the building energy research program can be accomplished with or without a reorganization of the present program structure.

If DOE is to have a role in research and development related to homes and buildings, then its programs aimed at this end should reflect an understanding of the industry and the economics and infrastructure involved in building, occupying, and maintaining homes and buildings.

The ill-fated building energy performance standards is no secret. Fortunately the Congress remedied that situation, although I was a little surprised to hear something this morning on that score that worries me a little bit.

Although DOE's attraction toward a regulatory approach to energy conservation and building has changed since BEPS, we would be hesitant to lump all building related programs together under a single banner. We know the present administration does not favor the regulatory approach to achieve energy conservation in buildings, but future administrations may not feel the same.

To change gears now, there is indeed a significant gap, in our view, between what we know now and what we need to know in order to efficiently apply conservation and active and passive solar heating and cooling techniques to homes and buildings.

Despite much of the fine work that has been done in those three program areas, in many instances the industry does not really have the answers to the following fundamental questions, and if the industry does not have the answer, then the consumer does not have the answer, and the consumer is the one that ultimately has to pay.

The questions are: What is it? How do I install it? What is its long-term performance? What is its performance in combination with other techniques? How much does it cost? What is the benefit

to the buyer in terms of energy dollars saved? Does it produce a safe and comfortable home? Is it marketable? I will be more specific a little later.

There are, in addition to our gaps of that type, a number of scientific questions—much scientific knowledge that we need, and I am going to illustrate that with just a few examples of points.

We have very little documented information on moisture migration through walls and ceilings and the extent to which, if any, that affects thermal performance; this constantly comes up.

Nor do we know the effect that large attic ventilation areas, which are good for summer cooling, have on wintertime performance of insulation. I am talking about the air motion effect.

There are large gaps in our knowledge about the seasonal performance factors of HVAC systems in relation to the climate and their degree of oversizing.

I may be challenged on this, but I believe there is no accurate method of predicting actual annual energy consumption for heating and cooling in homes and apartments, and that includes DOE too and related massive computer programs. Without the ability to predict savings accurately, cost/benefit ratios, which is the whole ballgame for the consumer, can only be estimated.

We lack information documenting the actual performance of numerous types of conservation and passive solar features that are added to existing homes.

Numerous knowledge gaps with respect to comfort and health. How tight can a home be? How much fresh air is necessary? What are safe levels of nitrous oxides, formaldehyde, carbon dioxide, carbon monoxide, and other related questions.

To return to the earlier mentioned fundamental questions, I think we may be reminded that nothing really happens to save energy until some builder, home or apartment owner, or prospective building owner decides to apply some of these energy conserving and passive or active solar techniques.

For them to be able to do so, we think the research results and the research itself needs to be end-use oriented. What we learn through research needs to be moved into mass market practice. To save the quantities of energy mentioned before, we will need to have passive and active technologies and advanced conservation techniques applied to one-half a million homes per year; that is 50 percent of production now; and later to 1 million homes per year; hopefully it will be 50 percent of the production then, and hopefully that will not be too long.

In my statement I have mentioned as the first three items the research on documented full-scale studies on occupied homes and buildings in a number of locations; programs like the class A, B, and C energy performance measurements program, which are very high on my list; and the need to take this information and validate it with various kinds of estimating and computer programs.

I would like to make it clear that I thoroughly support the scientific kinds of investigations that are being done in places like the National Laboratories and other places—the National Bureau of Standards, et cetera—but I think that without taking that information and applying it to homes and buildings, and making the measurements and determinations so that you can take that informa-

tion and convey it with some degree of assurance to buyers—if they spend the extra money for all these good things, how much are they going to save? I would liken this to medical research that focuses only on studies of the treatment and medicines without testing them on the patients; certainly no one in the medical field would try that. I think we are talking about the same kind of analogy here.

Well, there are a lot of other items that I have set forth here; I would like to highlight a couple in particular. The subject of apertures and switchable glazing and so on has been mentioned. It is very important. We need much more research in phase change materials, which are similar to heat tiles but intended for different temperature ranges. As a matter of fact, Dr. Maria Telkas, who works with us, had a hand in development of heat tiles.

We need more research on the ability of these PCM systems to absorb heat, sometimes referred to as "coolness storage". I am concerned that the research program has had so much emphasis on the heating side, with very little emphasis—just getting underway—with respect to cooling.

The southern utility companies and as far north as Boston are having critical peaking problems with, for example, the ability to store coolness. They might very well avoid the construction of very high-cost new facilities for producing electricity, and this in turn could prevent more rapid escalation of energy prices.

The whole subject of passive solar cooling is particularly important, and I would like to come back to a question that I believe one of the subcommittee meant to ask Mr. Tribble about shading.

Shading is the kind of thing that I believe has enormous potential. We can make theoretical calculations about it, but it would really be very simple to put a few mobile homes—you do not have to put them in the sun; they are already there—and devise some practical shading techniques, and measure before and after what happens.

I have been in small mobile homes with 3-ton air-conditioners in south Florida that are very hot; they are like a hot box; that is absurd. I have a 4,000-square-foot home that is air-conditioned with 3 tons. It is pretty energy conserving; it has got a lot of shading and a lot of other things.

The point is that there is a big opportunity there, and we do not really need a lot of theoretical studies; we need a few practical ones, and then I think that information can be turned over to industry, and they can develop the kinds of things that people can buy at the do-it-yourself centers to help shade their own mobile homes.

There are other techniques for passive cooling that are very important. This is a subject which deserves considerably more attention than it has received.

I have talked about indoor air quality. I would like to say that research should take three forms: Defining the allowable levels of potential contaminants, determining the actual occurrence in typical homes, apartments, and buildings of such contaminants simultaneously with air infiltration rate measures and outdoor air quality—sometimes it is better inside than out—and then conduct re-

search on measures to alleviate the indoor air quality problems that may exist.

For example, we ought to have research on such industrial hygiene techniques as elimination at the source, filtration chemical treatment, and other methods. This is a particularly important item, since the air-to-air heat exchanger, which is the only one that is proposed is a particularly expensive solution.

I would like to close by saying again that the industry is in no position to support the kind of research that is proposed in the building energy research program or that I have mentioned and the other people have mentioned for the reasons that have been stated.

I have appended as part of this statement a recently developed industry recommendation for passive solar research and development programs, which I have already mentioned as being appended hereto and the chairman has agreed can be a part of the record.

Thank you for the opportunity to present my views. I would be happy to try to answer any questions.

[The prepared statement of Mr. Johnson follows:]

STATEMENT OF

RALPH J. JOHNSON

before the

SUBCOMMITTEE ON

ENERGY DEVELOPMENT AND APPLICATIONS

of the

COMMITTEE ON SCIENCE AND TECHNOLOGY

U.S. HOUSE OF REPRESENTATIVES

on

BUILDING ENERGY RESEARCH

July 22, 1982

Mr. Chairman and Members of the Subcommittee:

My name is Ralph J. Johnson. I am President of the NAHB Research Foundation, Inc., a not-for-profit subsidiary of the 111,000-member National Association of Home Builders (NAHB). In normal times they employ over three million workers. With me today is Joe McGuire, Director of Regulatory Affairs for NAHB.

The NAHB Research Foundation was formed for the purpose of performing research, development and studies that would lower the cost and improve the value of homes, apartments and light commercial buildings. We perform this work for industry and government as well as NAHB. We have been especially active in the field of energy conservation and solar for more than the past fifteen years.

Mr. Chairman, thank you for the opportunity to appear before the Subcommittee today to present my views which, I believe, are representative of the home building industry on a Building Energy Research Program and specific recommendations "on research and development activities that should be supported by the Department of Energy pertaining to building energy conservation and active and passive solar over the next few years."

I appear before you as a scientist and professional engineer with more than 35 years of experience in housing and home building; as the recent author of the Builders Guide to Solar Energy; the developer of a number of energy conserving research homes, the first of which we built in 1956; as a person who attended his first solar energy meeting in 1955; the author of an Insulation Manual for conserving energy in homes and apartments in 1969; the co-author of the NAHB Thermal Performance Guidelines for Homes and Apartments developed in 1976; and as one who has been engaged in much research and development effort pertaining to practical energy conservation and the application of passive and active solar energy to homes and apartments.

I should also tell you that I have a bias. I believe, however, it is realistic and practical. For the more than 25 years that I have been involved in technical research and studies with NAHB and the Research Foundation, I have been concerned with energy conservation and the beneficial use of the sun's energy. The first research home that we designed and built in 1956 had a number of energy conserving and passive solar design features. For many years we have been in the forefront of activities aimed at reducing the cost, improving the value and comfort of homes and reducing operating cost for energy on a practical basis.

While we are greatly concerned with energy conservation and the practical application of passive and active solar techniques to new and existing homes, apartments, and light commerical/industrial and institutional buildings, we are most concerned about making homes affordable. While a few years ago one out of seven households could afford to buy a home, today it is more like one out of twenty for first-time buyers and one out of ten for buyers with substantial equity in an existing home. Commercial buildings, including rental homes and apartments, that were feasible a few years ago, are not today. Today's disastrously high interest rates make affordability a particularly crucial problem and this is directly related to much of what I will have to say later.

A recent NAHB Economics Division study, Decisions for the 80s, showed that four out of five home buyers of the future preferred energy efficient homes. It is clear that the buyer's motivation is the bottom-line - how much does it cost to heat and cool the home for the year? That is why cost effective and practical technologies must be developed through research if we are to both aid the American consumer and help to alleviate this nation's short and long-range energy problems.

A recent SERI study stated that "the proper design and application of passive technology in combination with active, photovoltaic and energy conservation technologies could reduce U.S. building energy consumption by more than 50% or 17 Quads annually by the year 2000." I believe this projection is quite optimistic unless interest rates are sharply reduced and the climate for developing a substantial increase in private investment capital is created. Surely also that projection depends heavily upon our national public policies and actions. Research to develop

affordable end use applications of conservation and active and passive solar techniques is the key. Even if the savings are only half the SERI estimate, that would translate into 8 million bbls of oils per day (at a seasonal efficiency of 50%) that we would not need to import. What a stupendous accomplishment - given other conservation measures in transportation and industry - that just might be enough to make this Nation independent of foreign oil.

Our massive housing characteristic data show that NAHB members have made great strides, since the oil embargo, in improving the energy efficiency of the homes they build. Some have gone farther and tried building passive solar features into these homes. Others, on a limited basis and where state financial incentives are high, have offered active solar water heating systems and to a much lesser extent, active solar space heating systems.

Today's more energy conserving homes represent the first step in expanding the application of active and passive solar heating and cooling techniques. There are success stories from a few builders in various parts of the country who have been able to experiment with energy efficient active and passive solar home designs and products. Unfortunately, for the vast majority of home builders this luxury does not exist. The home building industry is an industry of small businessmen. The thousands of subcontractors who participate in the industry are small businessmen too. The typical NAHB member in good times builds only 20 to 25 homes per year. Today, I expect the average is more like 10 homes per year. The largest building firm has much less than 1% of the market. This enhances competition and provides the home buyer with a much greater

housing choice than in any other country in the world. The disadvantage is that these small businessmen cannot afford, because their customers cannot afford, hundreds of thousands of small unrelated research programs. The same is even more true for the solar industry.

There are other reasons that these small businessmen cannot undertake research in conservation and active and passive heating and cooling technologies. Even if as much as 5% of sales was allotted to research, a number significantly greater than American industry generally allots to research, that might only be $40,000 per firm. If that had to be spread over 10 homes, that means a per home increase in price of $4,000 - hardly feasible or economically sound on a national basis. More importantly, home builders and the architects, engineers and subcontractors who serve the industry are not research scientists nor are they research oriented nor should we expect them to be. The marketplace requires them to concentrate on delivering the most value for the least cost.

It would seem to be almost nonsense to expect 100,000 builders, subcontractors, etc., to conduct proprietary research programs even if they were qualified. Today's home buyers are already greatly overburdened from rapidly rising prices for land, building materials, labor, increasing regulatory costs and especially from the sky-high interest rates imposed by the Federal Reserve Board.

With extremely few exceptions, the kind of research that in our view needs to be pursued does not result in any proprietary or product interest which results in some profitable return on investment for the builder as, for example, in the case of the automobile industry. Finally, home builders and others in the industry must be concerned not only with

energy and solar applications but with a host of other subjects ranging from land development through water supply, sewage disposal, materials technology, construction productivity, financing, marketing and many others. Since these all bear on the value of the builder's product, the home, he would have to allocate his research dollars to these and other subjects in order to be fair to his customers and stay in business. Obviously, little would be left for conservation and active and passive solar research.

The very nature of the home building industry is one of high risk made even higher by the yo-yoing of interest rates through the manipulation of the Federal Reserve Board - 7 times, believe it or not, in the last 10 years. But, very few builders have the inclination or financial ability to undertake the risk of experimenting with unproven products, systems, designs and technologies that may have seemed promising in small-scale laboratory studies but are unproven by research in actual homes. Those builders who do experiment do so with the full knowledge of a financial commitment over a long time span for they know they cannot experiment with the customer's dollars in such a precious product as their home.

Mr. Chairman, when I appeared before this Subcommittee last March concerning the DOE budget for fiscal year '83, I indicated support for the Building Energy Research Program concept. I did qualify that support by saying the program has much merit if it is structured properly, has the right goals and is designed to undertake projects that reflect the needs and energy problems of the building industry and the people it serves. I also said that the program should be much more end use application

oriented, should be screened in the concept stage and while ongoing to obtain industry input. Importantly, I said, it should reflect an understanding of the building process. I still support the program with the same provisos.

The Building Energy Research Program concept was the culmination of a number of discussion sessions by building industry, design and consumer representatives related to federal energy research programs aimed at homes and buildings.

These industry discussions were stimulated, I believe, by the realization that there was need for the Department of Energy's conservation programs to be more closely coordinated with the passive and active solar programs and attuned to the needs of the industry as, generally, has been done so well in the passive and hybrid heating and cooling system programs. We had hoped that such a program would help to focus on homes and buildings rather than on sometimes isolated, esoteric or infeasible subjects too often leading to research that even if successful might not have any practical application or use.

The letter of invitation to appear before you today indicated an interpretation of the Building Energy Research Program statement pertaining to reorganization that we, at least, did not intend. It is fair to say that the home building industry is for the integration but not necessarily the combination of the conservation and the solar programs. One reason is that competition between technologies both in the marketplace and in terms of research is healthy. What we mean by integration of these programs is not a type of reorganization, administrative consolidation or reassignment of responsibility but a close and

continuing cooperation of program management manifested in a planning process which, with active industry input, produces integrated annual operating plans. These plans should mesh with each other but more importantly should focus on research that can produce information and results that has at least the potential for practical end use application.

In short, I believe, the Building Energy Research Program can be accomplished with or without a reorganization of the present program structure. I tend to believe that in the interest of cost savings and the inevitable time delays associated with major reorganizations that if the general goals of the program could be agreed upon it could be carried out without a reorganization. But, let me emphasize again, the point of the Building Energy Research Program was not aimed at administrative or management issues but at research issues. The notion is a simple one. If DOE is to have a role in research and development related to homes and buildings, then its programs aimed at this end should reflect an understanding of the industry and the economics and infra-structure involved in building, occupying and maintaining homes and buildings.

There are some programs in DOE that have displayed a good understanding of the industry and have a record of successfull interaction with industry. The passive and hybrid solar program for one has displayed a healthy partnership with the industry in trying to solve problems and better utilize the sun and natural forces to use less fossil fuel.

On the other hand, the lack of understanding of the home building industry that was the basis for the ill-fated Building Energy Performance

Standards is no secret. Fortunately, the Congress remedied that situation. Although DOE's attraction toward a regulatory approach to energy conservation and building has changed since BEPS, we would be hesitant to lump all building related programs together under a single banner. We know the present Administration does not favor the regulatory approach to achieve energy conservation in buildings but future administrations may not feel the same.

I do not believe that the Building Energy Research Program proposal was an attempt to reorganize DOE or to mandate new programs. Rather, it was an honest attempt, by those whose business it is to know the technical issues related to homes and buildings, to set forth the subjects on which research is needed and which the industry itself cannot undertake alone.

Yes, there is indeed a significant gap between what we know now and what we need to know in order to efficiently apply conservation and active and passive solar heating and cooling techniques to homes and buildings without putting the research risk on the backs of already overburdened home buyers. Despite much of the fine work that has been done in conservation and active and passive solar, in many instances the industry does not really have the answers to the following fundamental questions:

- What is it?
- How do I install it?
- What will be its long-term performance?
- What is its performance in combination with other techniques?
- How much does it cost?
- What is the benefit to the buyer in terms of energy dollars saved?

- Does it produce a safe and more comfortable home?
- Is it marketable?

In addition, there are a number of gaps in our scientific knowledge about conditions that affect the performance of homes and buildings. Here are a few examples.

- We have very little documented information on moisture migration through walls and ceilings and the extent to which, if any, that affects thermal performance.
- Even such simple scientific facts as the temperature variation of the top surface of attic insulation is virtually undocumented. Without this information, one can only estimate what the real annual savings will be when attic insulation is added.
- Nor do we know the effect that large attic ventilation areas, which are good for summer cooling, will have on the wintertime performance of insulation.
- There are large gaps in our knowledge about the seasonal performance factors of HVAC systems in relation to the climate and their degree of oversizing.
- There is no accurate method of predicting actual annual energy consumption for heating and cooling in homes and apartments. There are many computer programs and hand calculation procedures for doing this, but none that we know of is validated. For example, our own experience with the DOE 2 computer program showed predictions of annual energy consumption for space heating 81 and 87% higher than actual in a year-long carefully controlled test of two homes. The same program under predicted

energy used for space cooling of these homes by 31 and 32%. The ASHRAE modified degree day calculation method did no better. And, it should be noted that these inaccurate projections were after adjustment for the actual local climate and adjustment for the actual air infiltration rates of the two homes. Without the ability to predict savings accurately, cost/benefit ratios, which are the whole ballgame for the consumer, can only be estimated.

- We don't really know enough about soil temperatures under homes to project their thermal performance with and without various amounts of insulation put in various locations around and/or under the foundation.
- We still do not know the net annual energy benefit of a square foot of southerly facing glazing on a city-by-city basis as changes are made in the numbers of layers of glass and window management techniques.
- We lack information documenting the actual performance of numerous types of conservation and passive solar features that are added to existing homes. Each salesman has a different number for the dollars that will be saved. So, it is no wonder that millions of families have not tried to retrofit their homes with energy conserving and passive solar features. They simply don't know whether the cost will be worth it.
- There are numerous knowledge gaps with respect to comfort and health. How tight can a home be? How much fresh air is necessary? What are safe levels for Radon? Nitrous Oxides? Formaldehyde? Carbon Dioxide? Carbon Monoxide? And the twenty or so other contaminants implicated as possible problems

in energy conserving homes? What, in fact, is the relationship between Mean Radiant Temperature (MRT), air temperature, relative humidity air motion and comfort? When the MRT is raised, say 4°F, in an energy conserving passive solar home, how many degrees can the thermostat be lowered for equal comfort? This knowledge has an important relationship to thermostat setting which, in turn, has a significant affect on energy saving.

- What new materials can be developed to sharply reduce the cost of active solar collectors?
- How can active solar systems be made more efficient and cost effective?

Time in no way permits listing even the major gaps in our needed scientific knowledge for applying efficient energy conserving and active and passive solar techniques to homes and buildings.

To return to the earlier-mentioned fundamental questions, may we be reminded that nothing really happens to save energy - by using energy conservation active and passive solar technologies and scientific information - until some builder, home or apartment owner or prospective building owner decides to apply some of these techniques. For them to be able to do so, we think the research needs to be end use oriented unless energy conservation and solar research is to be no more than a scientific exercise. What we learn through research needs to be moved into the mass markets. To save the quantities of energy mentioned before, we will need to have passive and active technologies and advanced conservation techniques applied to a half million homes per year - 50% of the market now, and later, to a million homes per year - hopefully, 50% of the

market then, assuming a return to something like normal housing production.

For this to occur, we need more research on the following subjects:

- Documented full-scale research on occupied homes and buildings in a number of locations is necessary to obtain sound answers to the key questions I mentioned above. Much research has been accomplished in the various scientific laboratories and in small-scale experiments. That is not enough. It is essential to carry on the additional applied research that will provide the practical answers that are needed to package and describe those results in forms that can be used by the industry.
- Programs like the Class A, B and C Building Performance Measurements Program are very high on my priority list. These should be expanded to include energy conserving as well as passive solar techniques. Other research is needed to isolate and measure individual effects of multiple techniques on homes and buildings under full-scale controlled conditions.
- The results of that kind of information can be used to further develop and, most importantly, validate large and small computer programs to enable industry to make parametric studies of the benefits of various techniques and especially to calculate with a reasonable degree of reliability actual energy savings related to the combination of various technologies. Hopefully, then, we will have the basis for getting mortgage lenders and appraisers to recognize the value of savings benefits. Currently, sentiment is developing to do just the opposite. From their point of view that is appropriate: namely, to penalize loan-

to-value and debt-to-income ratios for technologies with long payback periods that require the buyer to subsidize the debt service cost of the techniques selected during the early years of the mortgage when both the mortgagor and the mortgagee are at greatest risk.

- Not all of the needed research is in the field of full-scale buildings performance. For example, there are some very important materials research needs which we see no manufacturer being willing to undertake because of what they believe would be a limited and perhaps chancey market if the tax subsidies for active solar and related programs are removed.
- We need fundamental polymer research, for example, to try to develop low cost glazings and collectors and to develop techniques to produce durable high reflectance mirror type substrates for all kinds of solar heating and lighting applications. Research at SERI indicates that it is possible to make double glazed windows that have the heat entrapment capability of an average vacuum bottle. Further, research is needed to develop glazings whose heat rejection and light transmission characteristics can be controlled by application of electrical voltages. The development of super-efficient glazings is a key to building more energy conserving passive solar homes and buildings and developing more efficient active solar components. More laboratory and field research to develop "super glazings", if you will, that have high R and/or switchable characteristics is needed. Wintertime glazing performance needs to be reversed

for summer conditions. There are a number of promising possibilities for doing this.

- Much more research is needed on phase change materials (PCM) to help passive solar move into the mass housing markets. The physical chemistry of PCMs in aspirin bottle sized containers in laboratories is reasonably well established. But their performance in practical sized containers in homes and buildings is unknown. Further, solid-to-solid PCM research has barely begun. Research at SERI is underway and should be continued on these solid phase change materials that are available in large quantity and known to be nontoxic. Scientific data on temperature change in homes and buildings as it affects heat absorption and rejection from PCM containers are sorely needed. Development of containerized PCMs into satisfactorily performing systems in homes should be studied in full-scale prototype homes and buildings.
- We need much more research on the ability of PCM systems to absorb heat, sometimes referred to as "coolness storage". Most of the southern electric utility companies and many others as far north as Boston have critical summer peaking problems. Such research promises to alleviate peaking problems and to result in lower cost energy by postponing the need for very high cost new capacity since off-peak energy could be used in the coolness storage system.
- We have barely scratched the surface on passive solar cooling techniques including ventilation, shading, dehumidification,

evaporation and night sky radiation. So far, most research has been aimed at saving energy during the heating season. Yet, for much of the country the major load is for air conditioning. Theoretical studies on passive and hybrid solar cooling must be supplemented by full-scale studies on homes, especially existing homes and mobile homes, to learn how to apply the research results and document costs and savings so home owners and builders can make a judgment about the cost versus the benefit.

- Research is needed to find out how combinations of conservation and solar technologies really perform in actual homes and buildings. Also, what do they cost and how is the best way to do it?
- Major research should be undertaken to improve the operating reliability, durability and cost effectiveness of various active solar components and systems.
- Research on apertures for letting the sun's heat and light in and keeping it out when so desired is extremely important. Much more research on daylighting for both homes and buildings gives promise of substantial energy savings. Lighting is a major energy cost in many light commercial/industrial and institutional buildings and is not an insignificant factor in residential energy costs. Daylighting studies such as are underway at SERI and LBL to make resource assessments, perform basic and advance system studies, study combined daylighting and passive solar strategies and integrated system studies should be continued.

- Indoor air quality is becoming an increasingly important issue in energy conserving homes. Whether or not it is a problem, we don't know. Research is needed to: 1, define allowable levels of potential contaminants, both separately and in combination; 2, determine the actual occurrence in typical homes, apartments and buildings of such contaminants simultaneously with measurements of air infiltration rates and outdoor air quality; and 3, conduct research on measures to alleviate whatever indoor air quality problems exist or may develop. The current solution proposed - an air-to-air heat exchanger - is the most energy intensive. Research on such industrial hygiene techniques as elimination at the source, filtration, chemical treatment and other methods is necessary.
- Research is needed to improve the seasonal efficiency of various HVAC systems. Research on ground source, heat source and solar assisted heat pumps, vapor phase heat transfer, duct system losses and gains, total enthalpy controlled whole house ventilation, the affect of equipment sizing on seasonal performance and related HVAC systems research are all very important.
- There is an outstanding need for the development of design tools aimed at the specific different users - builders, HVAC contractors, engineers and architects. These people simply do not have the time, inclination, nor the ability, to translate highly complex mathematical presentations of research into a form that is practical for use. They should be translated into manuals, handbooks and guidelines usable by the doers in the building industry.

- Only a few communities have laws that protect solar access. To date, this has not been a marketing problem. As buyers become more sophisticated in taking a long range view, solar access preservation will be another significant research subject.
- Closely akin to solar access are the barriers to land development to optimize passive solar lots due to hidebound, cost increasing and antiquated codes. For example, most zoning ordinances do not allow side yard lot lines that are not perpendicular to the street tangent; they do not allow variable front, back and side yard setbacks; nor do they allow the siting of homes and buildings so that their facade is not parallel to the street tangent. Experience in a few progressive developments has shown that there is no reason whatsoever for disallowing these important techniques to aid passive solar home and building construction. "Soft" research on how to overcome these barriers to efficient solar energy use is essential.
- Our Market Research Department estimates there are 81,800,000 existing homes, apartments, condominums and mobile homes. The importance of research relating to these existing homes and other buildings cannot be overemphasized in relation to energy saving potential. They are not as energy efficient as the new homes that we are building and in any given year there are 81 times as many of them. Where applicable, all of the research subjects noted above should be extended to existing homes and buildings.

- In all cases, it seems to me that it makes good sense, when using public funds for research, to provide for the dissemination of the results in usable form so that the benefit of the research dollars can be realized. Such information must be targeted to the specific audiences and should be an integral part of a research program.
- I believe that industry advice on the feasibility of eventual use of some research subjects before they are undertaken would be a beneficial screening device. Also, a periodic assessment of the progress in application of the research results in all three of the programs would help to sharpen the focus of the research and make it more useful. Periodic meetings with expected industry users of the research should also help to make it more useful.

There are many more research subjects and projects that need to be pursued. Federal funding for energy conservation and active and passive solar needs to be extended for another three or four years to complement and bring to fruition much of the work that is underway and to undertake the needed new research. As noted before, industry is in no position to support such research.

Finally, there is appended hereto as a part of this statement for the record a very recently developed Industry Recommendations for Passive Solar Research and Development. This was prepared by an industry working group consisting of the National Association of Home Builders, the American Institute of Architects, the Brick Institute of America, the Northeast Retail Lumber Dealers Association, Lawrence Berkeley Laboratory representing SERI and Los Alamos Laboratory, the Passive Solar Industries

Council and the NAHB Research Foundation, Inc. This plan identifies in some detail five major programs: passive solar systems analyses; research on the development of new materials, prototype systems and components which are affordable and which may be integrated into existing buildings and systems and conventional practices; performance data acquisition and analysis including test cells and full-scale homes and buildings; design tool development and evaluation; and transfer of research results in. forms usable by industry.

Thank you for this opportunity to present our views. I would be happy to answer any questions.

APPENDIX

TO

STATEMENT OF

RALPH J. JOHNSON

before the

SUBCOMMITTEE ON

ENERGY DEVELOPMENT AND APPLICATIONS

of the

COMMITTEE ON SCIENCE AND TECHNOLOGY

U.S. HOUSE OF REPRESENTATIVES

on

BUILDING ENERGY RESEARCH

July 22, 1982

I. INTRODUCTION

Industry desires a working partnership in Federal building energy research activities. The benefit of active partnership, we believe, will accrue both to ourselves and the Federal research community. This has certainly been the case both here and in several other industrialized countries where such partnership exists. Close cooperation is both possible and necessary in order to achieve maximum effectiveness of government expenditures.

Passive solar systems combine conservation technology with climate conscious design, i.e. the supply of energy by the builder by capturing it from the environment. For this reason passive solar research and development has become a focal point of industry interest, concern and emphasis. We view passive solar energy technology as the core of buiding energy science. It provides an attractive bridge between largely defensive conservation techniques and advanced active solar technology.

The building industry has long recognized and supported the obvious need for cooperation and coordination between related Federal building energy research programs. However, the industry advocates separate conservation, passive solar, and active solar technology programs because inter-technology competition, both in the marketplace and in terms of research, is highly desirable.

Research competition can lead to a better research product and should ultimately result in significant advances in the way buildings are built in this country. Diversity allows choice by the user and promotes aggressive efforts to reduce costs. In any case, it is the industry's responsibility to integrate the best available techniques and products into real buildings.

It is against this background that the building industry recommends five primary objectives for consideration in planning for Federal R&D of passive solar energy systems over the next few years. Such a program should:

1. Broaden the single-focused scope of recent efforts (i.e. cooling technology research only) to include heating, cooling and lighting systems for both residential and commercial building applications.

2. Increase emphasis on applied research to extend and complement basic research activities.

3. Test all high potential concepts in occupied experimental buildings.

4. Include an explicit technology transfer function which encourages the adoption of passive solar technologies by the mainstream of the industry and recognizes the difference in perspective between researchers and industry practitioners.

5. Include industry participants in all aspects of R&D activities.

The balance of this paper presents building industry recommendations for structuring the Passive Solar Program in terms of broad program activities, which can also serve as the basis for developing a specific research agenda for FY-1983.

II. RECOMMENDED PROGRAM STRUCTURE

The building industry sees the need for five fundamental R&D activities within the Federal program:

1. Passive Solar Systems Analysis - Extrapolation of fundamental understanding of building energy mechanics to basic passive system concepts and configurations through experiment and analysis (e.g., use of computer simulation methods verified by real building performance).

2. Material and System Concept Development - Reserach leading to the development of new materials, prototype components and systems which have the potential to reduce building energy use in a cost effective manner and integrate well with conventional building practice.

3. Performance Data Acquisition and Analysis - Testing and analysis of hypotheses/results, in system prototypes (e.g., test cells) and experimental buildings.

4. Design Tool Development and Evaluation - Generalization of systems analysis and performance data results into computation algorithms, tables, plans, design details, specifications, construction methods, case studies, etc. for final development by members of the building industry.

5. Review, Evaluation, and Dissemination of Research Results - Documentation, consolidation and publication of results of all research activities in forms useful to and useable by industry organizations.

Projects within such a structure of functional activities will, and should, be interrelated (e.g., systems analysis work will require performance data, design tool development will require substantial systems analysis, etc.). Therefore, each category of program activity must have clearly defined (i.e. participatory) roles for both researchers and industry representatives. The industry recommends that working groups be established to be responsible for planning, coordination, and analysis of research results for directly related projects. At a minimum the working groups should consist of the principal investigators involved in all aspects of the work. These working groups should be informal (i.e. not institutionalized), and temporary, existing only through completion of the individual project. Lead responsibility for operation of the groups should be assigned to the organization (lab or industry) with the greatest immediate need for the research product. For example, a lab would be designated as "lead" for a working group concerned with simulation/analysis tool validation, whereas an industry organization would "lead" a group charged with development of an improved public domain design tool for builders.

III. RECOMMEND FY '83 RESEARCH AGENDA

Given the need to efficiently utilize limited resources, it is clear that informed judgment must be used in establishing a research agenda for the passive solar program. This section presents an industry perspective on the activities that should be undertaken in FY '83.

Broad project descriptions are presented for each functional activity area. The projects are designated for inclusion in a core program (C); a program at level funding (L); and an enhanced level of funding (E). Interrelationships between projects are described by identifying recipients of research results.

A. SYSTEM ANALYSIS

Systems Analysis should set the direction of Passive Solar Research and Development. Over the past three years, highly sophisticated and complex building energy analysis tools have been developed. These tools have been and can be used to identify high priority research needs for both residential and commercial building systems.

1. The first and overall priority of systems analysis work is to verify past analysis/simulation tool results against measured building performance data (e.g., Class A residential sites and commercial building performance data). Modify codes as required in order to achieve 10% ± accuracy. Results of this activity should be widely published and forwarded to program participants involved in design tool development and evaluation activities for consequent use. (C)

Beyond this effort it is practical to separate System Analysis activities into a residential and a commercial component.

Residential Systems Analysis

1. Carry out an assessment of integrated passive and hybrid heating and cooling subsystems for prototypical single and multifamily residential buildings. Focus on 2-3 promising passive/hybrid combinations and their interaction with both advanced and conventional HVAC systems; include off-season impacts and sensitivities. Recommend/identify areas of high potential for further research and development. Forward results to HQ and program participants involved in materials and system concept development. (C)

2. Identify the contribution of separate building parts (windows, walls, etc.) to heating and cooling loads in typical residential structures. Extrapolate results to predominant climate conditions encountered througout the U.S. Verify results where possible against real building performance. Forward resulcs to design tool development and evaluation participants. (L)

3. Develop a generalized characterization of glazing insulation systems, distinguishing between inside and outside locations, infiltration, infra-red heat flow and other characteristics, such as noise, security, privacy and

light control. Forward results to materials and system concept development and design tool participants. (L)

Commercial Systems Analysis

1. Perform comparative evaluations of promising passive and hybrid heating, cooling and daylighting (emphasis) system combinations in two commercial building types (e.g., office, retail, warehouse, etc.) and identify the top candidates. Follow this with sensitivity analyses to quantify performance and costs as functions of key design parameters for each candidate (design parameters may include orientation, facade treatment, placement and amount of thermal mass, advanced and conventional HVAC system types, etc.). Express the variation of design parameters in terms of their impact on building peak load and charges incurred under typical utility rate structures. Results that target existing technology should be forwarded to the design tool participants for refinement of construction and design specifications. Results that target advanced technology, should be summarized and forwarded to materials and system concept development participants. (C)

2. Examine the sensitivity of fluid velocities, temperature distribution and surface convection coefficients to variation in the boundary conditions in an enclosure of one or more zones. Use the resulting data base in the development of correlations for heat transfer coefficient to walls, columns, T-beams, concrete/masonry units and other structural elements. Forward results to design tool participants. (C)

3. Based upon completed assessment activities, identify boundary conditions for a variety of cooling techniques through experiment and analysis (e.g., use wind-tunnel tests to determine induced flow rates for natural ventilation). (L)

4. Develop data base describing present and future building stock demographics, including energy use/performance for all building types. Employ demographics in the systems evaluation task above as required. Forward descriptions of typical energy use patterns, if any, to the design tool participants. (L)

5. Use comparative evaluation results to investigate the impact of specific passive heating, cooling and lighting strategies on utility load profiles. Identify "typical" patterns, effects of passive technologies and ultimate effects on utility capacity requirements. Forward results to materials and system concept and design tool participants. (L)

6. Examine the feasibility of performing side by side testing of commercial scale buildings in order to compare retrofit strategies or to produce validation data for commercial buildings energy analysis techniques. Forward results of study to HQ and evaluate potential benefits with other working groups. (E)

B. MATERIALS AND SYSTEMS CONCEPT DEVELOPMENT

The purpose of these activities is to develop improved and cost effective materials, components and systems to serve the identified needs of the building industry for passive solar techniques. Activities should result in building components that can be readily integrated with typical U.S. buildings.

1. Develop improved (and potentially inexpensive) aperture control subsystem concepts for residential and commercial applications. Concentrating on improved seasonal loss/gain control, the concepts must address assemblies, glazing, installation requirements, expected performance, and cost/benefit. Identify highest potential concepts for laboratory testing. (C)

2. Develop advanced thermal mass container concepts for wood frame construction useable for both exterior and interior wall assemblies. Identify high potential concepts for physical model development and test by industry research organizations. (C)

3. Develop system concept studies for single story office building daylighting systems. Include schematic concept drawings, specifications, and potential costs and expected performance for a variety of solution options. (L)

4. Develop preliminary new daylighting system concepts and physical test models for large, multistory building applications. (L)

5. Develop preliminary system concepts for ventilation and other high potential passive cooling technologies, forward to systems analysis participants. (L)

6. Develop concepts for increasing thermal storage capacity, particularly for cooling, in "light-construction" systems for commercial and residential buildings. Forward high potential material or product modification concepts to industry research organizations. (L)

7. Investigate concepts to enhance heat transfer from moderate temperature (50-120°F) thermal storage to the living space in passive applications. Include consideration of controlling the heat transfer according to comfort demands. Forward to industry research organizations. (E)

C. PERFORMANCE DATA ACQUISITION AND ANALYSIS

The availability of measured performance data is one of the most critical needs industry has in its attempts to translate the achievements of research into practical solar applications in real buildings. These data are also vital to the development of design tools and the verification of simulation results.

1. Continue to collect, analyze and summarize experimental data from residential Class A sites for detailed building energy analysis algorithm validation and performance characterization for various passive subsystems. Forward results to systems analysis and the design tool participants. (C)

2. Compare mechanical systems experimental data with the predictions of

commercial building simulation tools. Forward results to systems analysis and design tool participants. (C)

3. Transfer responsibility for Class B and lesser complexity data monitoring activity to industry research organizations. Existing Class B data needs analysis and verification by industry in order to be useful. Further monitoring of additional sites is probably warranted. To minimize the cost and increase practicability, the Class B data collection must be simplified, i.e. applicable in industrial practice and understandable by the user. Forward results to systems analysis and design tool participants. (L)

4. Support the development of field research-verified technical information by industry's own technical information mechanisms and resources. The prime focus should be on measurements in real buildings, with cooperative builder and owner participation. Forward results to design tool and dissemination participants. (L)

D. DESIGN TOOL DEVELOPMENT AND EVALUATION

The purpose of these activities is to verify design tool accuracy against validated simulation results and actual performance data for passive solar systems, in both residential and commercial applications. Forward all results to dissemination participants.

1. Broaden capabilities of public domain passive solar design tools (e.g., SLR) to include comparative analysis of major conservation and conventional system alternatives. Incorporate analysis of off-season impacts of passive heating and cooling systems into existing public domain design tools. (C)

2. Establish test procedures for manual computation techniques and non-computational design aids, such as plans, tables, nomographs, etc. (C)

3. Establish a panel to assemble, review and comment on results of other design tool development and evaluation programs (to include California Energy Commission, TVA, and Battelle Northwest Laboratory efforts). (L)

E. REVIEW, EVALUATION AND DISSEMINATION OF RESEARCH RESULTS

Passive Solar research will be successful only when the results are translated into practical applications, and the knowledge gained is transferred to building industry practitioners. Technology transfer is not a commercialization activity, but an integral part of research, be it long or short term. In the past, Federal research has suffered from a lack of coordinated effort to evaluate, consolidate and disseminate research results for specific building industry audiences.

1. Document research program accomplishments to date. In particular, make available the technical information, generated by the program, in useful forms: i.e. provide brief, clearly written topical summaries of materials now difficuilt to access from governmental archives. Develop abstracts showing authors, specific subject, major conclusions, reviewers, scope and intended audience, in such a way that a decision by building industry organiations can be readily made about the applicability and usefulness of a given publication. Through industry's own professional organizations, select technical information which is immediately relevant to industry needs. This will require support for analytical and evaluation tasks. (C)

2. Consolidate and summarize the results of performance data monitoring activities for industry, along the principles outlined above. (C)

3. Identify industry representatives for participation in project working groups. They should take active part in the scoping, planning, conduct and evaluation of ongoing and future research activities. (C)

Mr. HARKIN [acting chairman]. Thank you all very much.

Mr. Cable, when you were at DOE, did you feel that the coordination between the building systems program and the passive solar program was adequate?

Mr. CABLE. In no way.

Mr. HARKIN. I like that kind of an answer. That is interesting.

Do you feel that the building systems program has paid adequate attention to passive solar?

Mr. CABLE. It was not part of the building systems' mandate.

Mr. HARKIN. It was not?

Mr. CABLE. No, sir.

Mr. HARKIN. OK. Should it be?

Mr. CABLE. I think you know from my testimony, I espouse an integrated program.

Mr. HARKIN. This question I am going to ask all of you, so you can be thinking about your answers if they differ from Mr. Cable's. How would you structure technology transfer programs to get the results of research efforts out to industry in a form that it can use in the cheapest, quickest, and most acceptable manner?

Mr. CABLE. How many hours do we have?

I would like to make a few remarks on it, but that is a question that requires a great deal of work to answer in an effective way.

There have been some very positive things that have occurred over the last couple of years in information transfer in regard to the Department's staffs working directly with a lot of groups from industry. I think they are exemplary of the type of activity that has to continue in perhaps much broader form. An example is that currently under way is a year-long series of articles in "Progressive Architecture" that discusses the results of several years' worth of research under the commercial buildings activities that we had responsibility for.

Why "Progressive Architecture"? It is one of three professional journals, and most practicing architects read all three of them. They were interested in the program, and they are doing an excellent series that whets your appetite. It tells you the results and tells you where you can get more detailed information.

The American Institute of Architects has totally reorganized their technical information and dissemination activity and hired an excellent man to head it up. Through their Publications Department, they are going through a lot of DOE technical work and looking at how it can be formatted for dissemination.

Those are two limited examples focusing on architects. I think a lot of things have to be done that cannot be done by the Government, but the Government has to have enough staff time available to work with the organizations so that the organizations can take it, package it for their readership in a way that it is going to sell; if it is free, we are wasting money; people have to pay for it to think that they want it, and then once they pay for it, they are going to use it in some way.

The other comment I would make is that a lot can be done in orchestrating reasonable media events to disseminate material. A lot of the passive solar and conservation activities around the country have resulted in buildings that are there and that people can go and see, and yet rarely, even though they attract a lot of press

and sometimes TV coverage, was that managed in a sustainable way?

In the private sector with something like that, you would milk it to death. You would have publications there; you would sell information; you would really work a physical feature that attracts people's attention to sell your product. I think an awful lot of attention could be paid to that kind of thing, but it takes staff. Typically, the characteristic of all those programs has been that with as many people and as much money, they were always asked to do more than was reasonable for what they had. So you get to the point of balancing what you ask them to do and then staffing it adequately.

Mr. HARKIN. Mr. Johnson.

Mr. JOHNSON. Commenting on the same question, Mr. Chairman, I think I said before, before this committee, the regional solar energy centers were doing an excellent job of translating information that had been the result of research to the private sector, to individual consumers, to engineers, to architects, to builders, to contractors, and I was sorry to see them go. I was not very familiar with the activities of Western Sun, but MASEC, NESEC, and the Southern Solar Energy Center I was familiar with, and we were sorry to see them go.

I think that kind of thing might be revived possibly in some different form. I think the first step in translating this research information is packaging it for the audience. You cannot expect a Ph. D. physicist or mathematician, or whatever scientist, to do other than produce a scientific report.

People who understand how architects think—other architects—should take that information, if it is applicable, package it in a form that is useful to that profession, and disseminate it, I would think primarily through their trade association—through the American Institute of Architects. The same is true for engineers, for builders, for HVAC contractors, or whatever. I think this is a key factor.

I really do not think that the research people generally should be doing this kind of thing. It ought to be done by, as I said, the people who understand the audience and have the unique combination of scientific background and education and knowledge of the particular segment or audience or industry to translate that into a useful form.

The same goes for information for consumers. There is all kinds of good information in the research that has been done, but consumers are not going to read the kinds of publications that come out.

As far as NITS is concerned, I always try to go— I like to call it that—you can hardly read what they say, because the copies are so bad, so we always try to get an original if we can from one of the authors.

I have never seen a NITS publication on the desk of a builder. I do not recall seeing it on desks of engineers or architects either. That is just not getting information into the mainstream where it can be used, and those are reprints of the professional, scientific reports that have good use in the scientific community but are limited in their application broadly.

Mr. HARKIN. While we are on the question, do you want to pick up on that, Dr. Balcomb?

Mr. BALCOMB. I think it is a question of having the right group do the job. Each group is most appropriate for one particular facet of this.

The researchers need to be guided in what kind of work to do, and we should go to the place where that work can be done best. I think track records have been established by different groups in various areas.

The group of people that submitted this proposal to you—just looking over the list—are the kinds of people who are excellent at the job of translating those results into the kind of information that their constituency needs. They know how to do that work.

The originators of the research may not be able to do that, and even if they did it and put it in a Government publication, the constituency might not get it, and if they got it, they might not read it because it did not come through the right channel.

I think that the key is making the right kind of ties. As a researcher, I would give you an example of an activity that we just completed. We will find in any one of these associations that there are people who understand both sides of this issue—a staff person.

In the National Concrete Masonry Association I worked with such an individual. I asked him what kind of things were needed. We discussed this, and calculations and evaluations were done, and some measurements. Out of this came an article on the heat storage effectiveness of concrete masonry units. That article was part of a publication, the "Concrete Masonry Solar Architecture Quarterly," and this was sent out to 25,000 people.

That information and its translation into a form that was suitable for those people is a difficult job, and I submit that they will read this but they probably will not read a Government report that might have the identical information in it.

The masonry industries are hurting in this country, as every group. They have a vested interest in passive solar, because they see it as a way to get more of their product into buildings, and so they are pushing it.

The same with the glazing industry. This is what has made passive solar happen in this country, not the Government advocacy. It is a fact that there, are industry groups out there that see it in their best interests to do it, and that is why there are 100,000 passive solar homes in this country at the present time.

That potential can continue if the information is available. The job of the National Labs ought to be knowledge generation, not packaging the stuff.

We saw these instant bureaucracies jump into being when the solar energy centers were set up and so forth, and mostly they spent an awful lot of time trying to educate some people in what to do—to then translate it. I think those handles are available to us through the trade associations, if we know how to use them properly, but we do have gaps in fundamental knowledge, in my estimation.

Mr. JOHNSON. One more quick comment, Mr. Chairman. Another excellent way we have found with homebuilders, architects and engineers who are interested in residential work and HVAC contrac-

tors—a series of technical seminars, or workshops if you want to call it that, of 1, or 2, or 3 days, depending on the subject matter and the coverage, conducted by the National Association of Home Builders with appropriate kinds of people on the teaching staff; these are well attended and give an opportunity to translate results in a useful form to the people they are trying to reach. They are very useful—this seminar approach.

Mr. HARKIN. There is one last thing that I have, and then we will move on to the next panel. None of you mentioned, or I did not see it anywhere, taxes. Is there any kind of tax system that can be used to encourage technology transfer? Has the industry focused on that at all?

We have always had a problem in the past on solar energy; you would have tax credits for active solar and that type of thing. I have found a lot of builders in my area who are very interested in the active solar because of the tax credits, but they say, "passive? What is that?"

Mr. JOHNSON. We have favored the passive solar tax credit in the past. I would like to ask Mr. McGuire to comment on that.

Mr. MCGUIRE. Mr. Chairman, we have found through polling our members through our energy committee that the passive solar tax credit was thought of as an incentive to get builders to do it and as a complement to the technical information that they would need to go out and actually do it. Our members have been supporting that for a number of years now.

Mr. CABLE. I would like to comment on that, as a private homeowner. I just bought a house, and I just went in and did some fairly massive renovation; I am going to move this weekend. Absolutely part of the decisionmaking criterion was how much tax credit I could get on what issues; there is no question about it.

I feel that a well orchestrated tax credit program is one effective mechanism to encourage translation of things, and I found that, although many trades people that I had to deal with were not knowledgeable when I tried to talk about heat transfer of Btu, they sure knew if what they dealt with dealt with a tax credit or not.

Mr. HARKIN. OK. We have all kinds of information systems set up, but builders read the information and they say, "Well, it is going to cost me money, and I do not know if I will get a return." You might as well have not had any kind of information transfer system at all.

Mr. CABLE. It has got to be a lot more effective.

Mr. HARKIN. Yes.

Mr. FUQUA. I have one quick question about the National Labs. Did you ask about the National Labs and their role?

Mr. HARKIN. No, I did not.

Mr. FUQUA. Maybe all three of you would have something to say about that.

Mr. CABLE. I think the National Lab system is one of the great treasures of the United States. It is the repository of technical skill and talent that does not exist anywhere else. My blood curdles when I hear people say that the Labs should not be involved in buildings research.

When I first came to work for Dr. Savitz, straight out of an architectural practice, and I was told that, "Well, you are going to

have to use these Atomic Energy Commission labs to get a lot of this work done, I thought she was crazy."

When we went out and made field trips and we met these people, my mind changed immediately, because one of the real reasons that Dr. Balcomb, Dr. Rosenfeld and many, many others that you have heard testify from time to time and many that you have not—these people bring an approach to the technical issues that is not normally part of the thinking of the architectural and the engineering profession. They are researchers, and they are scientists, and they explore problems in a different way, and they have made tremendous advances that would not normally have been made or certainly would not have been made as fast as they have without that hybrid interdisciplinary approach.

I personally felt, with all due respect to some of my dear friends in solar, that SERI and the regional solars were an incredible waste of money, because I think the National Lab system is more than capable of demonstrating the technical expertise needed, and I also think that the most appropriate information dissemination is through existing channels, not to create another set of them even though some of the regional SERI's clearly did do a very nice job.

Mr. BALCOMB. Of course I believe that the National Labs have an important role to play, and part of the reason for that is because of the way in which they are organized. Most of them are fairly large scientific groups that have a base of capability in material sciences which can be tapped, and this enables them to efficiently and effectively go and do the right kind of research in a fast way.

The important thing is to manage that activity in such a way that it is most productive. I have cited some of the issues that I believe are important in the management area, but I am not sure that the DOE knows effectively how to manage a research type of program.

I would welcome a change which encompassed a better and broader understanding of research.

Mr. JOHNSON. The National Labs have done a lot of fine work in the research field. I am not sure that it is done efficiently. Dr. Balcomb has mentioned some reasons why.

Personally, I would like to see two things, and I think I reflect the views of our industry and many of the people that serve it. One is to have more industry input in the beginning and during the research process—one of screening, one of providing some advice, taking a look at the key question which is, even if the research is successful, it may not be worth a darn, because you cannot use it or because it costs too much and has no chance of being useful. I think that is a very important aspect.

I think the second item relates to proportion of funds. If there were unlimited funds, that is one situation, but I think conducting 100 percent or a very huge percent—a majority—of the funding available for research in the National Laboratories, which by their nature are isolated, are highly scientific—and that is good for that part of it, but there is another side to it. I likened it to medical research. If you do not try it out on patients, you will not find many doctors using it, and if you do not try it in buildings and homes, you are not likely to find out how to use it effectively, how much it costs, and what it will really do.

Mr. HARKIN [acting chairman]. Thank you all very much for your testimony and for being here today.

Mr. FUQUA. Gentlemen, we appreciate your testimony.

Our next panel will include Mr. Gardner McBride, of the Building Owners & Managers Association, International; John Eberhard, Executive Director of the Advisory Board on the Built Environment of the National Academy of Sciences; and Dan Morgenroth, of Owens-Corning Fiberglas.

We will start with you, Mr. McBride.

STATEMENT OF GARDNER McBRIDE, BUILDING OWNERS & MANAGERS ASSOCIATION, INTERNATIONAL, WASHINGTON, D.C.

Mr. MCBRIDE. Thank you very much.

Mr. FUQUA. If you gentlemen have prepared statements—which you do—we would be happy to make them part of the record. If you wish to summarize, that would also be welcome.

Mr. MCBRIDE. I would be delighted to do that.

My name is Gardner McBride. I am the executive vice president of the Building Owners & Managers Association. We represent principally the high-rise office building industry, about 1 billion square feet of commercial office space in this country.

We support the principle of integration of the various research elements in the Department of Energy, but we have two concerns. The first one we all share together: We do not want to see dollars wasted on duplicative effort. We would like to see some means of an ongoing consensus among the various groups who come before you with their separate agendas as to what the important agendas are to pursue.

In the testimony that has been presented before you this morning by excellent people, there is some divergence of viewpoint. You are getting a heavy dosage of what each person's angle is on the whole energy field, what their constituency problems are if they are trade association executives. In my own prepared testimony I focus on lighting and cooling. That happens to be the big need for office buildings. You expect that. But there is an efficiency that could be had if we could fight out some of these battles among ourselves with good will, keeping ourselves honest and keeping ourselves accountable in a way that could bring together some consensus on what the real emerging priorities are.

Fortunately, Congress has already set up a forum for us to do that, and it is called the National Institute of Building Sciences. Its purpose is to help us sort those kind of things out. I would like to strongly recommend that we use what Congress has already provided as a means—the National Institute of Building Sciences is a means to sort out some of these priorities among ourselves.

I believe that they are staffed adequately. The work that they have done has been good. They need to be built up to handle this particular project, but I think that would not be expensive, and I would like to suggest that I for one, representing one constituency user group among the buildings industry, would be more than delighted to sit down and begin to express my concerns in front of my colleagues and in front of those who do basic research and say, "Here's what we need; here's what we have got to have. You want

us to sell the concept of energy conservation. You want me to sell it to my members in the office building industry. These are the kind of tools I am going to need." And let other people say what they need, and let us sort that out. Let us have DOE representatives present so they can hear it sorted out, instead of having each of us go through the door one at a time, stating our case, and taking endless time.

When we do get to the issues of long-range research versus short-term research, I have a couple of observations.

First of all, long-range research is very necessary, and many times the cutting edge of technology is beyond the expertise of the trade association, with the exception of some members within it perhaps. But I believe that the kind of interchange of information between the people at the National Labs and some of the research groups around the country and the practical problems that are represented by the trade associations—that interaction would be tremendously valuable for both groups. Again, I see NITS as a good forum for carrying that out.

On the short-range problem, the real issue for my association—I will let others speak for themselves, but I think I speak pretty generally for anybody who sits in my chair, and I am the chief staff officer of a trade association—the real problem is that a member of the association wants point-of-decision information. He is looking for consumers' reports: "Can you rate it for me, Gardner?" is the kind of question I get: Who has done it before, and did it work? More importantly: Who did it before, and why did it not work? These are the kinds of questions that they really ask—no different than the kinds of questions your constituents would ask you if they could ask you these same kind of questions, for indeed they are the same people.

In order to do that, we need some sort of ability to get rating information. That, gentlemen, does require some analysis of ongoing buildings: What is really working? You changed the technology; what did it do?

While the models—DOE-II, et cetera—are fine models, and although I am familiar with them, for I have had research projects that I have had to pay for out of my association budget to pursue them—although they are useful, I will tell you right now, they are not as sensitive when you are dealing with the newer technologies as they are for the older technologies. In consequence, there are always doubts in people's minds: Well, they were standardized on research that had to do with variable volume, but here we have got something that is a different kind of heating system, and we are using a passive technique—or whatever it might be—and does it really relate?

Those questions are going to be best answered by continuing to take a look at actual, in practice technology applications and what really happened. That information, gentlemen, I can make immediately useful in the field, and it will lead to changes in the behavior of building owners and operators.

Thank you.

[The prepared statement of Mr. McBride follows:]

BOMA INTERNATIONAL
BUILDING OWNERS AND MANAGERS ASSOCIATION INTERNATIONAL
1221 Massachusetts Ave., N.W.
Washington, D.C. 20005
202-638-2929

John H. Windsor, Jr., RPA
President
Ronald L. Simpson, RPA
First Vice President
Roland O. Downing, RPA
Secretary-Treasurer

Gardner S. McBride
Executive Vice President

Office of the Executive Vice President
Gardner S. McBride
1221 Massachusetts Ave., N.W., Washington, D.C. 20005
202-638-2929

75 YEARS
1907-1982

TESTIMONY OF

BUILDING OWNERS AND MANAGERS ASSOCIATION INTERNATIONAL

ON

AN INTEGRATED APPROACH TO FEDERAL RESEARCH AND BUILDING ENERGY RESEARCH

PRESENTED BY GARDNER S. McBRIDE
EXECUTIVE VICE PRESIDENT, BOMA INTERNATIONAL

PRESENTED JULY 22, 1982
ENERGY DEVELOPMENT AND APPLICATIONS SUBCOMMITTEE
SCIENCE AND TECHNOLOGY COMMITTEE

Good morning, I am Gardner McBride, and I am Executive Vice President of the Building Owners and Managers Association International (BOMA). Our association represents the owners and managers of over 1 billion square feet of office properties.

Nowhere is the U.S. government's objective to conserve energy more warmly received than in the office building industry. There is a clear awareness of energy's vital role in the underpinnings of our nation's economy and in assuring our national security. Energy is the largest controllable expense of BOMA's membership, whose annual energy bill runs well over 1 billion dollars -- making conservation necesssary to remain competitive in the marketplace.

Clearly, BOMA's membership has a major stake in the activities of the U. S. Department of Energy, and it is my intention today to present BOMA's position on "An Integrated Approach to Federal Research and Building Energy Research" which is being considered by this Subcommittee, and the need to develop building energy technology and disseminate this information to the industry groups which will use it.

BOMA supports, in principle, the building energy research program being considered by this Subcommittee because it consolidates the activities of the primary federal research programs concerned with buildings; the Building and Community Systems Program and the Active and Passive Solar Energy Program; and private sector programs into one activity permitting more efficient use of the limited federal funds

available.

However, it appears that this proposal lacks specificity, and many of the program project goals could be a duplication of research already completed or currently in progress. In order to insure a more efficient use of federal dollars it is important that projects in the private sector are not duplicated by DOE. To this end we support a coordinating secretariat between government and the private sector which would disseminate information and prevent duplication of projects.

For example, it seems that DOE will duplicate the efforts of ASHRAE's "Standard Methods of Expressing and Measuring Energy in Buildings" in draft standard 105p which includes the establishment of data base similar to the one in this proposal. Other portions of the program under consideration by this Committee could duplicate much of the "National Program Plan for the Thermal Performance of Building Envelope Systems and Materials" being conducted by Oak Ridge National Labratory. Still other portions of the proposal seem to overlap with the "Building Energy Efficiency Project" which BOMA is participating in with the National Institute of Building Sciences (NIBS) and many other groups to identify market opportunities for low risk, high yield energy technology.

It is vital that a coordinating body exist to prevent duplication and distribute information. NIBS was created for just this purpose by

Congress. BOMA has found that NIBS has carried out this goel well.

BOMA strongly urges that any research in new and innovative techniques for energy conservation not yet found in the marketplace, particularly in the critical areas of lighting and cooling, be encouraged. The office building industry depends on such research to identify and analyze the specific new technologies which should be pursued by the private sector because the lead time to introduce new tecnology is so long in our industry.

Even more importantly, the office building industry needs research information on product and program reliability under actual field conditions in commercial office buildings in order to evaulate which system can be utilized best. DOE support may be most effectively utilized in this effort.

Without such information, barriers exist to significant further energy consevation progress on an industry-wide basis. Barriers in the form of unwillingness to try new products or services unless very short term paybacks seem likely. Due to the tremendous capital costs and long term capital recovery period involved, the decision to purchase new energy systems must be based on well documented evidence of energy savings and information on payback period. This information is vital to any decision to institute any capital outlay in order to conserve energy.

Existing office buildings are trapped in a "Catch-22" situation. Space in existing structures is tied to multi-year leases which often preclude passing on the capital costs of the energy saving systems to the tenants, but the escalation clauses of the leases require that any cost savings realized be passed on to the tenants. Upon installing a new energy saving system, the building owner may discover he is bearing the additional cost of the large capital cost of the system, but he now receives a much smaller (or even negative) increase in his rent due to the energy cost savings.

With these limitations and the very competitive office building market, the office building owner and manager needs to have the best data available to select a system. DOE can help provide this information.

A great deal of information needs to be exchanged among the office building users, owners, suppliers and the the Department of Energy. Each of these groups has information and needs a means for coordination and exchange of data. BOMA has found that the National Institute of Building Sciences has done this extremely well. NIBS, which was chartered by Congress for this purpose, has been instrumental in the increased building energy efficiency we have seen to date. It is the ideal organization to disseminate DOE's important research to the commercial building industry and its suppliers. BOMA's experience with NIBS has demonstrated that NIBS is an excellent interface between government and industry.

In conclusion, I would like to reiterate BOMA's support for the continuing building energy technology research of the Department of Energy. Yet research alone, without reliable reports of its practical application and realistic assessments of what it will take to transfer new technology into industry practice, may prove to be of significantly less value in addressing America's current need to conserve energy resources. The economic situation our industry faces requires that building management have access to information on product reliability. We encourage DOE to produce this information.

Furthermore, we feel that there should be a coordinating secretariat which disseminates information, prevents the duplication of research and is able to make the federal government aware of areas in which research would be useful but is not currently being conducted. BOMA has found that NIBS has served this purpose in the past and should continue to do so, as was mandated by Congress.

Mr. FUQUA. Thank you, sir.
Mr. Eberhard?

STATEMENT OF JOHN EBERHARD, EXECUTIVE DIRECTOR, ADVISORY BOARD ON THE BUILT ENVIRONMENT, NATIONAL ACADEMY OF SCIENCES

Mr. EBERHARD. Good morning. Thank you.

I am John Eberhard, the Executive Director of the Advisory Board on the Built Environment of the National Academy of Sciences. We have recently completed a study—in fact, officially delivered it only this morning—to the Department of Energy on a long-range research agenda very much related to the subject of these hearings. I am submitting that for the written record, with your permission, as my written testimony, and I would like then, as a private citizen with considerable experience in research and development, as a professional who was at one time president of the American Institute of Architects Research Corp., to make some brief remarks on the material which was sent by your committee to me for comment.

Mr. FUQUA. Without objection, your full statement will be included in the record.

Mr. EBERHARD. First the question of integration of the two programs: In my judgment, as many other people have said this morning, the reorganization that is implied within DOE is less important than the concept, which is also espoused, of dealing compre-

hensively with the questions of energy in its relationship to buildings and building activities.

Whether or not reorganization is necessary to accomplish for that purpose, should be left to the judgment of the administration and the Department of Energy.

I would strenuously object to the notion that a good reason for having these two activities integrated is to get more efficient use out of limited dollars. I think that is the wrong strategy. We should not be talking about more limited dollars for conservation and solar energy; it is already a disproportionately small amount of the budget of the Department of Energy. We should be taking a positive stance that both of these areas are important, are needed, and should be funded by the Congress of the United States. We shall not accept the position that we are going to have less money in these areas in the future.

The second comments are on the program itself. If I can say this somewhat facetiously, when I came here this morning, I said, "Mr. Building, you are named after Speaker Rayburn. Tell me, how do you feel about your use of energy?" I did not hear a thing. I said, "Mr. Rayburn Building, I have walked all around the outside of you, and I do not see anything in your design that reflects the climate here in Washington. How do you feel about that?" It did not say a thing. I came inside the building then, because I thought maybe it was deaf on the outside, and I said, "You have activities going on here that are important to the Nation, Mr. Building. Are you providing a comfortable setting for those activities?" I did not hear a thing.

It does not surprise you, I am sure, because buildings do not behave. Buildings do not speak. Buildings do not use energy; people do. It is you, and I, and us, and our requirements that determine whether or not energy is needed. A ghost in the middle of New Mexico requires no energy, because there are no people there.

The one change, obviously, that I recommend is that the priorities suggested in this document of research begin with human requirements. If people are working together in an office building, if people are working together in a Federal building where hearings are held; if people are sick and are in a hospital; if people live the private part of their lives that they live in a home, that is what generates the requirements, and to talk about the behavior of the house or the buildings seems to me ill-placed. It is human behavior that determines energy use. As you just said a moment ago yourself, Mr. Chairman, when your air-conditioner went out, your behavior changed. Even if your air-conditioning did not go out, you could change the nature of the energy-using requirements in your home by changes in your behavior.

We do not have to change people's behavior in order to save energy, but people do. Therefore we should understand—and that is the research question—the relationship between human activities, human behavior, and how energy eventually gets consumed.

One last point: We very easily toss around the word "energy" here, and we should be very clear that when we are talking about reducing the use of energy or increasing the efficiency of energy, we are talking about fossil fuels. Certainly, we do not mean to reduce the use of solar energy, because that is free; we do not mean

to reduce the use of conservation, which is another means of achieving energy efficiency. When we say "energy" we probably ought to often substitute the words "fossil fuels," because that is what we are interested in saving.

Thank you.

[The prepared statement of Mr. Eberhard follows:]

NATIONAL RESEARCH COUNCIL
COMMISSION ON ENGINEERING AND TECHNICAL SYSTEMS
2101 Constitution Avenue Washington, D.C. 20418

ADVISORY BOARD ON THE BUILT ENVIRONMENT

OFFICE LOCATION:
JOSEPH HENRY BUILDING
21ST STREET AND
PENNSYLVANIA AVENUE, N.W.

July 19, 1982

The Honorable Don Fuqua, Chairman
Committee on Science and Technology
US House of Representatives
Suite 2321 Rayburn House Office Building
Washington, DC 20515

Dear Mr. Fuqua:

Thank you for your invitation to testify at a hearing of the Energy Development and Applications Subcommittee on "Building Energy Research." I am submitting for the record a copy of the report "An Integrated Approach to Federal Research on Building Energy Use," recently prepared by a Committee of the Advisory Board on the Built Environment of the National Research Council/National Academy of Sciences/National Academy of Engineering.

This report details recommendations for a long term research agenda on conservation issues related to buildings and community systems. While it parallels in many ways the report The Building Energy Research Program on which these hearings are based, we believe that your Committee will find the range of issues much broadened, and the detail provided much deeper than that report. We have submitted our report to the Department of Energy and it is with their knowledge that we are entering it into your records.

Sincerely,

JOHN P. EBERHARD,
Executive Director

JPE:ddg

Enclosure

JOHN PAUL EBERHARD
Executive Director
Advisory Board on the Built Environment
National Academy of Sciences
Washington DC 20418
(202) 389-6348

EDUCATION

University of Louisville, Speed Scientific School, 1947
University of Illinois, School of Architecture, B.S. Architectural Design, 1952
Harvard University, Graduate School of Business Administration, 1958
Massachusetts Institute of Technology, School of Industrial Management, M.S. Industrial Management, 1959

AWARDS

Midshipman, U.S. Navy Reserves (Holloway Program), 1947-49
Alfred P. Sloan Fellowship, Massachusetts Institute of Technology, 1959
Engineering News Record Citation as Construction Industry Contributor, 1970
Fellow, The American Institute of Architects, 1977

MEMBERSHIPS

Member, The Cosmos Club, Washington, D.C.
Corporate Member, The American Institute of Architects
Member, Washington-Metropolitan Chapter, The American Institute of Architects
Member, Association for the Advancement of Invention and Innovation

PROFESSIONAL EXPERIENCE

Executive Director, Advisory Board on the Built Environment, National Academy of Sciences, Washington, D.C. 1981 -
Director, Architectural Research Associates, Washington, D.C., 1978-1981
President, AIA Research Corporation, Washington, D.C., 1973-1978
Dean, School of Architectural and Environmental Design, State University of New York at Buffalo, 1968-1973
Chairman of the Board, Building Science, Inc., Buffalo, New York, 1971-1973
President, Buffalo Organization for Social and Technological Innovation, Inc. 1969-1971
Director, Institute for Applied Technology, National Bureau of Standards, 1966-1968
Deputy Director, Institute for Applied Technology, National Bureau of Standards, U.S. Department of Commerce, 1964-1966
Consultant to Assistant Secretary of Commerce for Science and Technology of the U.S. Department of Commerce, 1963-1964
Visiting Lecturer, School of Industrial Management, Massachusetts Institute of Technology, 1959-1963
Consultant, Sheraton Corporation of America, Director of Research, 1959-1963
Alfred P. Sloan Fellowship, School of Industrial Management, Massachusetts Institute of Technology, 1958-1959
President (and one of the incorporators), Creative Buildings, Inc.,1952-1958
Partner, Eberhard & Murphy (architectural firm), Urban, Illinois, 1953-1958

A RESEARCH AGENDA:
ENERGY CONSERVATION IN BUILDINGS AND COMMUNITY SYSTEMS

FOR

THE OFFICE OF BUILDING ENERGY RESEARCH AND DEVELOPMENT
THE U.S. DEPARTMENT OF ENERGY

Advisory Board on the Built Environment
National Research Council
Washington, D.C.

National Academy Press
Washington, D.C., 1982

NOTICE

The project that is the subject of this report was approved by the Governing Board of the National Research Council, whose members are drawn from the councils of the National Academy of Sciences, the National Academy of Engineering, and the Institute of Medicine. The members of the committee responsible for the report were chosen for their special competences and with regard for appropriate balance.

This report has been reviewed by a group other than the authors according to procedures approved by a Report Review Committee consisting of members of the National Academy of Sciences, the National Academy of Engineering, and the Institute of Medicine.

THE NATIONAL RESEARCH COUNCIL was established by the National Academy of Sciences in 1916 to associate the broad community of science and technology with the Academy's purpose of furthering knowledge and of advising the federal government. The Council operates in accordance with general policies determined by the Academy under the authority of its Congressional charter of 1863, which establishes the Academy as a private, nonprofit, self-governing membership corporation. The Council has become the principal operating agency of both the National Academy of Sciences and the National Academy of Engineering in the conduct of their services to the government, the public, and the scientific and engineering communities. It is administered jointly by both Academies and the Institute of Medicine. The National Academy of Engineering and the Institute of Medicine were established in 1964 and 1970, respectively, under the charter of the National Academy of Sciences.

This report was prepared under Contract Number DE-AC01-77-CS20436 between the National Academy of Sciences and the U. S. Department of Energy.

For information regarding this document, write the Executive Director, Advisory Board on the Built Environment, National Research Council, 2101 Constitution Avenue, Washington, D.C. 20418.

Printed in the United States of America

COMMITTEE ON ENERGY CONSERVATION IN BUILDINGS
AND COMMUNITY SYSTEMS
FOR PHASE II

Chairman

RICHARD C. JORDAN, Professor and Associate Dean, Institute of Technology, University of Minnesota, Minneapolis, Minnesota

Members

MICHAEL GRIFFITH, Ph.D., Director, Research and Development, Owens-Corning Fiberglas Technical Center, Granville, Ohio
JEROLD W. JONES, Associated Professor of Mechanical Engineering, Coordinator of Conservation Studies, University of Texas, Austin, Texas
PRESTON McNALL, Chief Building Physics Division, Center for Building Technology, National Bureau of Standards, Washington, D.C.
GERSHON MECKLER, Partner and Director of Engineering Design, Haines Lundberg Waehler, New York, New York
RICHARD G. STEIN, FAIA, The Stein Partnership, New York, New York
JOHN ZEISEL, Ph.D., Zeisel Research, Cambridge, Massachusetts

Consultants

American Consulting Engineers Council, Washington, D.C.
Thomas V. Tiedeman, Director of ACEC Research & Management Foundation
Edward J. Lisee, Program Manager of ACEC Research & Management Foundation
Colorado Energy Research Institute, Lakewood, Colorado
Martin D. Robbins, Director
Natalie A. Langue, Consultant, Advisory Board on the Built Environment, Washington, D.C.
Thomas Vonier Associates, Inc., Washington, D.C.
Thomas Vonier, President
Peter Smeallie, Vice President

Staff

John P. Eberhard, Executive Director, Advisory Board on the Built Environment, Washington, D.C.
Joan D. Finch, Program Manager
Delorse M. Thompson, Secretary
Delphine D. Glaze, Secretary to the Executive Director

11-221 O—82——8

ADVISORY BOARD ON THE BUILT ENVIRONMENT
Spring 1982

Chairman
PHILIP G. HAMMER, Consultant to Government and Industry

Members
WERNER A. BAUM, College of Arts and Sciences, Florida State University, Tallahassee
RICHARD BENDER, College of Environmental Design, University of California, Berkeley
WILLIAM S. BIRNEY, United States Steel Corporation
JAMES M. BROWN, School of Law, George Washington University
G. DAY DING, Small Homes--Building Research Council, University of Illinois, Urbana-Champaign
PAUL C. GREINER, Edison Electric Institute
ROBERT C. HOLLAND, Committee for Economic Development
JOHN C. HORNING, General Electric Company
JOHN T. JOYCE, International Union of Bricklayers and Allied Craftsmen
STANISLAV V. KASL, Department of Epidemiology and Public Health, Yale University
MORTIMER M. MARSHALL Jr., Architectural Consultant
ROBERT P. MARSHALL Jr., Turner Construction Company
GLORIA S. McGREGOR, Chevron-Shale Oil Project
MELVIN A. MISTER, U.S. Conference of Mayors
C. E. (Ted) PECK, The Ryland Group, Inc.
L. R. SHAFFER, U.S. Army Construction Engineering Research Laboratory
ARTHUR C. STERN, The University of North Carolina, Chapel Hill
WARREN H. TURNER, American Telephone & Telegraph Company
SHIRLEY F. WEISS, The University of North Carolina, Chapel Hill
JOHN H. WIGGINS Jr., J. H. Wiggins Company

Liaison Representatives
LEE S. GARRETT, Department of the Army
MAXINE SAVITZ, Department of Energy
RICHARD N. WRIGHT, National Bureau of Standards

Ex-Officio
JOSEPH H. ZETTEL, Western Solar Utilization Network

PREFACE

Background on Phase II: Energy Conservation in Buildings and Community Systems

This report presents the results of a study conducted by the Advisory Board on the Built Environment (ABBE) for the Office of Building Energy Research and Development (BERD) of the U.S. Department of Energy (DOE). The purpose of Phase I of the study, initiated in 1976, was to conduct an evaluation of the mid- and long-range research, development, and demonstration program of DOE's Division of Buildings and Community Systems (BCS). During the course of Phase II, the Division of Buildings and Community Systems was reorganized into the Office of Building Energy Research and Development.

After spending some time reviewing written documents and speaking with the staff of BCS, the committee for Phase I concluded that BCS had no clear objectives or overall plan that could be critiqued; therefore, the original assignment could not be carried out. In its Phase I report, completed in February 1979, the committee noted the difficulty of completing its original task, and offered to outline a coherent program for BCS. After considerable delay, due mainly to reorganization within BCS as well as to the change of Administration after the 1980 election, the committee's offer was accepted and Phase II began in April 1981.

The intent of Phase II of the study was to develop rather than critique a long-range research agenda for BERD. A new steering committee was appointed, headed by the chairman of the original parent committee, Richard C. Jordan. The work plan for Phase II evolved into three major activities. The first was a period of background research and information gathering in order to propose possible areas of interest and potential research to be included on the agenda. This work was carried out primarily by consultants to the project. An annotated bibliography of the sources consulted during this activity appears in Appendix A of this report.

The second activity was a two-day meeting of the steering committee to review the consultants' material, structure a preliminary agenda, and prepare for a workshop to be held in February 1982. Several possible structures were suggested, discussed, and examined for their potential success as an agenda of energy conservation research. The format and goals of the workshop also were determined. It was decided that each committee member would choose six experts in the energy

conservation field to attend the February workshop and to serve on a panel chaired by that committee member.

The agenda was reviewed at the workshop on several levels. All participants were invited to respond to and critique the agenda as a whole, or any part thereof. Each panel was then assigned a specific portion of the agenda to review and comment upon in detail. The result was a revised agenda that included suggestions for several subject areas and topics that had not been included in the preliminary version. A draft final report was reviewed by a number of persons selected under the procedures of the National Research Council. This report presents a combination of the results of the February workshop and the comments from various reviewers.

EXECUTIVE SUMMARY

This report presents an agenda on research needs in the field of energy conservation within buildings and communities to be supported by the federal government. The agenda is developed in a futures perspective, presenting material that would be relevant for research and development five or more years from the present. The introduction provides an overview of agenda setting in general, pointing out some of the difficulties as well as possible approaches that any group might encounter while planning research for future, as yet unspecified, needs. A set of boundary conditions was created to help determine subject areas that should be a part of this agenda. This proved to be a useful tool for those developing the agenda, as any subject matter that did not satisfy the boundaries or criteria was eliminated.

The agenda is presented in the body of the report. Twenty-seven subjects are described as appropriate for areas of research. They are organized into six categories--broad classes of interest under which all related research can be grouped. A description of each category and area is provided, along with suggested topics of specific research projects. The appendixes provide an annotated bibliography of sources consulted while developing the agenda, biographies of the chairman and committee members and list of the workshop participants.

ENERGY CONSERVATION AND THE BUILT ENVIRONMENT: INTRODUCTION TO AN AGENDA FOR RESEARCH TO BE SUPPORTED BY THE FEDERAL GOVERNMENT

The prevailing world energy situation points to a need to redirect our building technology fundamentally. In order to meet the growing energy challenges of the late 20th century it will be important to rethink the design criteria for buildings and community systems, to modify the technology that for the past 35 years has been used for producing buildings, and to utilize our built environment in new ways that are less dependent on fossil fuels. This transition to a more energy conserving built environment takes place amidst a global technological revolution in information and communication systems, the impacts of which will likely parallel those of the industrial revolution. How this context of rapid technological change will advance the purpose of fossil fuel conservation will be the basis for a third phase study in 1982-1983.

This research agenda, developed in 1981-1982, is oriented toward developing a technology and techniques that support an approach to building capable of closely matching the needs of human occupants to micro-climate conditions. All human activity within and around buildings takes place amidst a set of energy forces, the central generator of which is the sun. The work presented here is based on the perception that our built environment is dependent on purchased energy--the oil, gas, coal and other forms of energy that must be bought and paid for. This agenda recognizes that new and existing buildings and communities must be moved toward increased reliance on abundant sources of ambient, nonpurchased energy, and that energy conservation will facilitate this transition.

The implications of a research agenda developed along these lines extend well beyond energy. They are linked inextricably with an entire social, political, and economic context and encompass concerns that range from employment to environmental quality.

THE NATURE AND ROLE OF ENERGY CONSERVATION

The conservation of energy is a basic response manifested in virtually all aspects of nature. Its relation to buildings, communities and society is no less fundamental. Richard C. Jordan, chairman of the committee for this effort, has described this relation and our present predicament well:

> This profligate society, energy based and until the 1960s energy exporting, has paid little heed to energy conservation practices until very recently. This has been true not only in the United States but to a lesser degree in other developed areas of the world. In 1978 the United States consumed 29% of the world's energy; Europe, including communist Europe, 41%, and the Far East dominated by Japan, 18%. Thus developed societies still consume 88% of the world's energy.
>
> The American Institute of Architects estimates that energy conservation could reduce the requirements 20% to 50% in older buildings and, in new construction, between 50% and 80%. One of the major barriers to more rapid achievement has been the public view of energy conservation as representing austerity and deprivation; alternative energy sources and particularly solar energy have had much greater appeal and glamor. Yet enhanced conservation is a preliminary need if alternate energy resources are to economically phased in.
>
> The rubric "energy conservation" is many faceted and includes at least the retardation of heat losses through the use of more insulation and better construction; the substitution of low-cost energy resources such as solar and wind for nonrenewable energy resources, such as oil and gas; the development of storage techniques to conserve energy at times when it is most readily available; more efficient conversion of fuels such as gas and coal into heat and electrical energy; the use of improved cogeneration systems; the development and use of natural light guides in supplement of incandescent and fluorescent lighting; and computerized load management techniques for energy conservation. Although the US cannot "conserve" its way out of the energy dilemma, energy saved by conservation will probably always be cheaper than energy obtained from coal, oil, gas and nuclear, or from any of the promising future energy candidates such as solar, nuclear fusion and synthetics. Thus, it is in the national interest to maximize both the application of known energy conserving techniques and research on further energy conserving developments.*

---

*Jordan, Richard C. "Research and Development Priorities for Energy Conservation in Buildings and Community Systems." Technology in Society, Vol. 3, 1981.

THE CHALLENGES OF AGENDA SETTING

One distinctive feature of the 20th century is the deliberate intervention of technology to control change for specified societal ends. The use of technology to solve critical problems and the use of research and development to drive such change are subject to misunderstanding due to our seeming inability to get ahead of the problems we perceive. This calls for an approach to agenda setting that is open ended, capable of adjusting to, if not altogether anticipating change. The research described in a research agenda will include solutions to problems that exist in the future as well as those present today.

Among the factors which have helped to shape this agenda is the conception that the built environment is an integral system, in which the behavior of each component affects the behavior of the whole, sometimes in unpredictable ways. This concept cannot be imparted fully to a research agenda, but is nonetheless critical in shaping a better understanding of the interconnected influences of climate, people, systems and operating procedures. Ultimately, the reason for conservation related research is to produce better knowledge on how to design, build and manage the components of the built environment. This must be done with recognition that the parts affect the whole.

ORGANIZATION OF THE RESEARCH AGENDA

As in any attempt to present complex information about complex subjects, the developers of this agenda grappled with the problems of taxonomy and classification. The following conventions were adopted because they are relatively simple and seem well-suited to the information:

- o Categories, of which there are six, are intended to be very broad collections of subject matter, within which various elements can be presented;
- o Areas are group related subjects of research interest that fall within categories but are still broadly based; and
- o Topics are illustrations of the kind of specific subjects to be explored within an area, but are not intended to be definitive.

The character of categories, areas and the topical illustrations is a direct result of the suggestions and recommendations that came from the people involved in generating and reviewing the agenda. While clearly not suitable as a plan for organizing a research program or as a method for describing energy use in the built environment, this research agenda is organized to convey a set of recommendations relating to research substance. No attempt has been made to set priorities between research categories or areas. As national goals and aspirations shift, as administrations bring changed political philosophies, and as agency management sets its own priorities based on internal strategies, priorities will also change. This agenda provides

a wide range of alternatives for setting program choices and current priorities.

BOUNDARIES SURROUNDING THE AGENDA

The process of building an agenda requires the inclusion of some research areas and the exclusion of others. As a result of limitations imposed on this project by its sponsors and as a result of disciplines imposed by the committee itself, the following conditions were established to help determine which research areas would be included in the final agenda:

- The research area should be concerned with the built environment, not with an issue so fundamental that it is no longer recognizable with regard to its applicability (e.g., research on the fundamental properties of matter), or so far on the development end of the scale as to be an actual design problem.

- The research area generally should address issues that are national in scope rather than those of only local or even regional interest, with some obvious exceptions.

- A distinction should be made between research areas of broad public concern and interest, justifying public investment at the federal level, and those most appropriately pursued by private investment (although judgment is often needed for research that might appropriately be started on public funds and then continued through development by private investment).

- The research areas should be concerned with the demand side of the energy equation, not the supply side. This suggests that research related to new types of solar collectors or wind turbine generators, for example, are outside the scope of this agenda.

- The problem or opportunity addressed should be perceived as one that will still be of major concern at least five years from the present, not solved or changed to a new and different problem or opportunity.

- The research area should be considered fruitful and worthy of continued exploration; that is, more than marginal gains in knowledge are left to be developed.

It became clear to the committee and others associated with these efforts that the boundaries are not always easily fixed; reasonable people can and will disagree over whether, for example, a research area strays from the demand side of the energy equation into the supply side. There are gray areas--some forms of solar collectors must be integrated directly with ways of designing and constructing buildings

and therefore become an integral part of the built environment and the energy conservation measures taken.

The committee recognizes that these relationships exist and that not all people will be satisfied with the items included in or left out of this agenda. However, the committee has agreed that the areas included on the agenda generally meet the boundary conditions.

A FINAL WORD ABOUT THE AGENDA

No agenda, regardless of the quality of people or the amount of time available for its development, can profess to have captured the complete range of potential for innovation and constructive change. Unquestionably, major developments have occurred in this field that were not and probably could not have been charted on an agenda of research to be undertaken or supported by the federal government. Rather, they were the product of efforts by individuals and organizations whose attentions were directed by a general climate of enthusiasm and support for energy related research. Often these developments came as a result of experiments and forays that were not supported by federal dollars directly but could not have occurred in a context that did not have federal support. The very network of energy enthusiasts and frontier-oriented experimenters has been fostered, but not always directly funded by the federal commitments in these areas.

The point to be made is that advances, breakthroughs and fundamental changes in the energy area are not likely to occur as the result of either federal spending or private spending alone, and will perhaps bear little or no relation directly to an agenda for technical research rooted in the scientific method. Design professionals from abroad who learn of American progress in the energy area are repeatedly amazed by this country's apparent freedom to test, experiment, build and evaluate, even when results are disappointing and produce no immediate benefit. They recognize what we too often fail to see: That it is this very climate of apparently undirected and unplanned inquiry that sometimes yields the most exciting, lasting, and productive results. The American building community, unconcentrated and comprised mostly of hundreds of thousands of small-scale businesses, has a long tradition of operating well in relatively unbridled circumstances.

With regard to energy, the importance of the federal role in fostering a general attitude and eagerness to learn cannot be overstated; the proceeds of federal dollars spent in this area extend well beyond the scientists, professionals, and researchers immediately involved in the work, in ways that cannot be charted on an agenda for research. It is anticipated that this climate of apparently undirected inquiry can be made even more productive through adoption of the information and computer-based society we are now embarked on. This country would do well to continue to encourage, by all means available, this intellectual and technical climate, for it holds what might be described as the greatest promise for the future.

Category 1: OCCUPANT & USER INTERACTIONS WITH BUILDINGS AND COMMUNITIES

It is the satisfaction of human needs for comfort and for meeting the functional patterns of buildings and communities that places demands on fossil fuel. In the absence of human users there are few building functions or community operations that would require any energy. User interactions with buildings and communities, therefore, drive the agenda for any well structured program. Understanding and controlling the interactions of buildings and communities with the natural environment (Category 2) may have physical science considerations of materials' degradation or may be studied from the perspective of the meteorologist, but any energy conservation agenda is derived primarily from conditions of human needs and satisfactions. Similarly, understanding and improving the interactions of the mechanical and electrical systems of buildings and communities (Categories 3, 4 and 5) must be related to an understanding of user requirements.

The following areas are a linked set of research questions; they are mutually dependent. To explore the efficiency and quality balances of a building's use, one must understand how to define and measure the well-being of its occupants. To achieve the well-being of users there must be some means of controlling the conditions of the environment in which users are located. One means of achieving the controlling fit between the built environment and the users is to provide for adaptation of the solutions to changing conditions. All of this must be achieved within a framework of market conditions, user requirements, and regulations which tend to advance or restrict the nature of the solutions. The diffusion of new or improved technologies is impacted by market conditions, the regulatory climate and legislative action.

The six areas of research which follow from this analysis are:

1.1 Energy Efficiency, Cost-benefits and the Quality of Life

1.2 Well-being Related to Comfort, Safety and Health

1.3 User Controls of the Built Environment Conditions

1.4 Adaptation of Solutions to Changing Conditions

1.5 Market Conditions and User Requirements

1.6 The Regulatory Process and Energy Conservation

1. OCCUPANT AND USER INTERACTIONS WITH BUILDINGS AND COMMUNITIES

1.1 ENERGY EFFICIENCY, COST BENEFITS AND THE QUALITY OF LIFE

Efficiency can be measured in terms of the effectiveness of the solutions compared to the associated costs of those solutions. It also can be measured in terms of the ratio of the useful energy delivered by a solution to the energy supplied for the solution. These concepts are understood more readily as they are applied to machines, but there is also a conceptual basis for using "efficiency" as a means of understanding the appropriate use of energy to make a building or community responsive to the functional requirements and comfort needs of the users.

Cost-benefit analysis has become a recognized method of evaluating the trade-offs between levels of human satisfactions and the associated costs of meeting those performance levels. While this report is concerned primarily with research driven by questions of science and technology, the economic consequences of alternatives should be considered in terms of the costs and benefits. Energy conservation programs always will be faced with these trade-offs, but this seems especially important to understand as the increasing cost of fossil fuels tempts owners and providers of energy using systems to reduce the level of performance to save money.

Solutions to providing buildings and communities with energy using systems are a total response to human requirements (e.g., a setting for health care, or education, or work, or living our private lives.) How efficiently the solution serves the requirement for which it was intended can be measured in terms of the productivity of workers in an office, or in health care services delivered. Or efficiency could be concerned with the "appropriate" use of spaces (for example, an educational program that could be housed effectively in 10,000 sq. ft., but is utilizing more than 20,000 sq. ft., is placing a demand on energy support systems that is inefficient.) On still another level, energy efficiency can be measured with respect to the operation of equipment proposed for the solution in terms of the second law of thermodynamics.

Examples of research topics in this area are:

1.1.1 Develop better models of the interactions of energy costs and the benefits to users of buildings and communities in order to assess the threshold conditions needed (this contrasts with most existing models designed to determine maximum energy allowances based on price alone).

1.1.2 Develop an understanding of how to define and measure appropriate energy requirements in terms of efficient use. Users will vary in preferences, needs and requirements, and responsiveness to energy alternatives, thus extending the complexity of the analytic methods needed.

1. OCCUPANT AND USER INTERACTIONS WITH BUILDINGS AND COMMUNITIES

1.1.3 Develop measures on the relationship between density of community design solutions and how density relates to the quality of alternatives to the solution. Variables such as cultural backgrounds and perceptions of the users will influence measurement of the quality of the solutions.

1.1.4 Develop analytical methods for evaluating the trade-offs between density of urban design solutions and solar access rights.

1. OCCUPANT AND USER INTERACTIONS WITH BUILDINGS AND COMMUNITIES

1.2 WELL-BEING RELATED TO COMFORT, SAFETY AND HEALTH

The concept of "well-being" is meant to encompass a large number of the actual or occupant perceived attributes of buildings and communities. Not all of these attributes are related exclusively to the conditions provided by energy using systems, so that a clear understanding of all of the factors that contribute to the performance of spaces (e.g., safety conditions) needs to be achieved in order to better understand the impacts that energy conservation programs will have. The common design standards for ventilation, lighting, temperature and humidity control already have been tested in energy conservation programs and consequently are now being questioned. If safety issues are added to the parameters of comfort and health more complex questions of these interactions arise. For example, there is reason to be concerned about the incidence and spread of fire in spaces that have been tightly sealed to reduce air infiltration problems.

Ensuring the health, safety, and welfare of citizens is a fundamental role of government. Consequently, it follows that government should support the research required to understand, evaluate, design and test these conditions under various energy conserving alternatives. There are added concerns related to understanding the long-term liabilities which energy efficient solutions might contribute to the degradation of health, comfort or safety attributes. Most of the research areas identified in Categories 3, 4 and 5 will produce effective or usable solutions directly in proportion to how well they satisfy the conditions of human well-being.

Typical research topics would include:

1.2.1 Develop methods of analysis of comfort oriented psychometric data; that is, the perception of comfort or well-being by the users of the space that extends the limits of instruments customarily used in environmental systems.

1.2.2 Develop methods of analysis that contribute to a better understanding of building safety impacts of conservation programs.

- o As a subset of 1.2.2, research is required to better evaluate the impact of energy conservation alternatives on individuals with physical or mental limitations, especially the elderly.

1.2.3 Develop performance criteria and measures of testing ventilation to integrate new knowledge on the interdependence of air quality, fire safety, and energy requirements.

1. OCCUPANT AND USER INTERACTIONS WITH BUILDINGS AND COMMUNITIES

1.3 USER CONTROLS OF THE BUILT ENVIRONMENT CONDITIONS

In addition to control devices used to operate mechanical and electrical systems, there are control measures based on having sufficient information to know how to correct one's own sensory environment. There also are clear differences in the controls that individuals use to modify the indoor environment of their living or working spaces to achieve a level of well-being, and the controls that a group of users require to avoid abuses by any individual member of the group. The delivery of healthy, safe and comfortable settings for human activities by an appropriate use of energy usually is achieved when the system's controls are exercised by those most directly affected. As is true of any good systems design, it is also important for the control mechanisms to be linked to feedback loops used in maintaining the operating characteristics of the system within predetermined boundaries.

Among the topics which could be explored within this area are:

1.3.1 Determine the requirements of special population sectors (for example, the elderly and the very young) that would suggest customized control measures being made available to them. The susceptability of these two groups to hypothermia could be an example of special requirements.

1.3.2 Develop a better understanding of the deprivation which people may experience if they have little or no control over their own access to outside views, as a result of rooms without windows.

1.3.3 Develop better methods for determining the perceived satisfactions of users to the quality of light, the amount of fresh air, or the temperature gradients of a room.

1.3.4 Develop methods of evaluating the total efficiency of buildings and communities in relation to the mix of individual, group and automatic control methods.

1. OCCUPANT AND USER INTERACTIONS WITH BUILDINGS AND COMMUNITIES

1.4 ADAPTATION OF SOLUTIONS TO CHANGING CONDITIONS

If solutions to building or community designs are to be capable of adapting to the changing conditions of use, there must be some means to achieve this adaptation. Adaptation can provide a quick response to the changing conditions of the daily cycle of use, night and day conditions, or climatic changes. When adaptive responses are built into design solutions there is less need to predict the required performance characteristics of the energy using systems. In addition the control systems can be made more responsive to the desires of the occupants. There is also an adaptive requirement for buildings and communities over long periods of time as characteristics of users change (for example, the population of a community grows older, or new users take over, or a school building becomes a local government office). The general concepts of "loose-fit, long life, and life-cycle costing" each become important to the development of adaptive solutions.

The following topics are among those to be considered in this area:

1.4.1 Identify conceptual models for heating, ventilating and air conditioning systems that are adaptive to changing conditions of building and community use. Both short-term cycle and long-term cycle models are required.

1.4.2 Identify the life style changes which have been made by many persons in response to the increasing costs of fossil fuels. The results of these analyses would provide indicators of the adaptive means humans use to respond to the changing en- ergy picture, and could provide guidance to policy makers for further studies.

1.4.3 Conduct studies of changing working/living arrangements to better understand how technological changes such as computer terminals in home offices may cause a societal adaptation to a major new form of working/living arrangements.

1. OCCUPANT AND USER INTERACTIONS WITH BUILDINGS AND COMMUNITIES

1.5 MARKET CONDITIONS AND USER REQUIREMENTS

There is a general argument that suggests that more than enough knowledge and sufficient methods are available to conserve a great deal of energy, but market resistance to new conditions and new methods has become the major obstacle to improved energy efficiency. Governments need to know more about how to overcome the natural resistance to change in order to advance the diffusion of new technologies. This appears to be true particularly in the area of energy conservation since it is the user's requirements that drive energy demand. Many believe that a great deal of energy can be conserved within an economic framework that is more soundly formulated than the accounting concept of "payback." Evidence demonstrating new economic propositions should be assembled and, if the evidence is clear, other reasons for resistance to sound decision making should be studied.

Research topics associated with this area include:

1.5.1 Develop a better understanding of how cultural patterns and personal values influence choices of new technologies and techniques. While the private sector has done a great amount of market research in order to sell products and services, it appears that not much is known about market acceptance of conservation programs that are not tied to products.

1.5.2 Develop a better understanding of the institutional factors that appear to offer the best means of accelerating diffusion of new technologies. This includes an analysis of resistance of organizations which are employed in designing, manufacturing, assembling, regulating, financing, and managing the built environment.

1. OCCUPANT AND USER INTERACTIONS WITH BUILDINGS AND COMMUNITIES

1.6 THE REGULATORY PROCESS AND ENERGY CONSERVATION

Among the barriers and, under some circumstances, incentives to the introduction of new energy conserving innovations into the marketplace are regulations at various levels of government. The regulations are incorporated in building codes, zoning ordinances and tax provisions. Recently there has been a series of steps taken to reduce the regulatory climate at the federal level with the belief that free market forces are sufficient to induce energy conservation decisions. The regulations which remain at the state level (based in most states on ASHRAE 90-75R) are prescriptive in nature with special provisions for evaluating alternative design solutions based on the comparative method. There is a lack of understanding about how, and in what ways, these regulations may encourage or discourage innovations in the marketplace.

This understanding also is lacking with regard to special tax provisions designed to encourage private investment in energy saving measures. For example, quick development of energy saving short cuts may occur simply as a means to utilize the investment tax credit. In the short-term this will create a favorable, highly visible impression that the building industry is concerned with saving energy. However, many investments may be made on products that will eventually erode from disrepair and non-use because they produce no lasting energy conscious design solutions. Such questionable benefits achieved in the short-term may have a highly negative impact upon the long-term objectives set forth in this research agenda if consumers see "energy conservation" as a risky venture.

The policy related research topics included in this area are:

1.6.1 Develop evaluation methods for total building or community performance (providing for well-being with appropriate levels of energy use) in order to measure the impact of various regulations in terms of their costs and benefits.

1.6.2 Develop test methods related to performance criteria in order to provide free market conditions for the introduction of innovative energy conserving concepts. Most test methods are tied to prescriptive specifications for existing solutions and consequently do not allow free competition for new concepts.

1.6.3 Facilitate the rapid development of computer-based design and engineering methods that will provide the potential for code and zoning requirements that are also written in computer usable formats.

Category 2: INTERACTION BETWEEN THE BUILT AND NATURAL ENVIRONMENTS

The exterior walls (or skin) of a building are a mediating element between the conditions of the natural environment--air, water, earth, light--and the internal building conditions required for various human activities. The energy using mechanical systems make up for the deficiencies; the construction of the building determines at what rate that deficiency will have to be made up. There are various components of the natural environment useful for the operation of the building--heat, air movement, air quality, humidity and precipitation, and light. All of these may be excessive on either side of the building skin, requiring a transfer from one side to the other. This transfer may be achieved either directly through the skin or indirectly through mechanical plants, along with the make-up quantities of heat, heat removal (cooling), light, humidification, dehumidification, air purification, air movement and air replacement.

Moreover, geographical differences in natural environmental conditions require completely different responses in building forms (with technological and social constraints taken into consideration). For example, the various climatic conditions in different parts of the world produce different requirements for buildings and cities. The cities in the Southwest and in Alaska, for example, are, or should be, quite dissimilar.

Not only does the natural environment affect the design of cities and regions, but they, in turn, affect the environment. Large urban areas with their massive heat retaining materials, reduced vegetation and accelerated water runoff modify the natural environment significantly. For example, the temperature and wind patterns (both diurnal and prevailing) around New York City have changed sharply in the last few decades. The coal combustion and high stacks have changed the air quality of the Northeast and introduced the damaging effects of acid rains. The water consumption patterns in Phoenix and Tucson have lowered the water table by many feet, creating both structural problems and problems related to sustainable growth.

The act of building transforms not only the direct site of the building, but also requires the relocation of various parts of the natural environment from around the world to the building site in the form of building materials and components. This modification of the natural environment has far-reaching consequences in terms of desertification, deforestation, abandoned quarries and mines, flooded plains and modified shore lines. These modifications may also be changes leading to new and desirable stabilities, as in the clearing of farm land, the planting of orchards or the controlling of flooding. In addition to the existence of the changes outlined, achieving them has required the expenditure of large amounts of energy for the extraction,

transformation and transportation of these materials. Excluding the human energy that has gone into the production and placement of building materials, the countless millennia of solar energy that have produced our fossil fuels and the cosmic forces that have created the diversified minerals in the earth's crust, the purchased energy to produce and install the materials used by the construction industry amounts to over 10 percent of our national energy use. This has been termed the embodied energy in buildings.

These interactions between the built and natural environments and their energy consequences can be grouped and discussed in four main areas:

2.1 Interaction between Man and the Natural Environment as Moderated by the Built Environment

2.2 Building Form Responses to the Natural Environment

2.3 Changes in the Natural Environment Resulting from Building Energy Uses

2. INTERACTION BETWEEN THE BUILT AND NATURAL ENVIRONMENTS

2.1 INTERACTIONS BETWEEN MAN AND THE NATURAL ENVIRONMENT AS MODERATED BY THE BUILT ENVIRONMENT

Approximate calculations of building energy flow are used routinely as a basis for building design. However, those currently in use are of limited utility. Those which are simple enough to be useful in the early design stages of a project tend to be rather limited in scope. They are one-dimensional (for example, all heat transfers are assumed to be of one dimension), steady state or quasi-steady state, and consider a limited, linearized temperature and solar load interaction with the natural environment. Some analytical programs that extend consideration to a wider range of variable inputs also are one-dimensional, at best quasi-static, and not responsive to the dynamic nature of energy flows. An additional shortcoming is that they have limited use as design tools because the required input is so extensive that a design must be fully specified before these programs can be applied. An energy study of several design trade-offs can require prohibitive time and expense.

Perhaps the most serious fault of both types of analysis is that they presume a uniform and static (or quasi-static) interior condition independent of changing needs for conditioning the interior space due to variations in occupancy, activity or interaction with the external environment. They do not explicitly address the basic function of the built environment; that is, to moderate the natural environment to meet human needs. The objective of this research area is to provide a sound, scientific basis for modeling the built environment--a filter or moderator between the natural environment and the needs of the individual for a comfortable, productive environment. This will require an order-of-magnitude improvement in our ability to model energy flows between man and the environment.

There are at least four aspects to the modeling process, all of which must be capable of varying over time:

- Describing the radiative, convective, and conductive environment required for human activity and modeling the interaction between the individual and the interior space;
- Modeling the interaction between the interior and exterior surfaces of the building, and modeling the interaction between the various control and equipment components that make up the building service system;
- Modeling the interaction between the building's external surfaces and fenestration and its site specific environment; and
- Modeling the site specific environment as a function of surrounding buildings, vegetation, landscape, topography and climatic conditions.

11-221 O—82——10

2. INTERACTION BETWEEN THE BUILT AND NATURAL ENVIRONMENTS

Many elements of the basic model exist but have not been applied in an integrated way; other elements are yet to be developed.

Examples of required research in this area include:

2.1.1 Develop two- and three-dimensional heat transfer analyses which will provide realistic distribution of temperatures over the various interior surfaces of the space and yet be manageable in terms of computation time and capacity. Variations in surface temperatures have a definite effect on occupant comfort.

2.1.2 Analytically describe advanced room climate control strategies which integrate sensing of air temperature, radiant temperature, air motion and humidity (operative temperature sensors).

2.1.3 Determine the appropriate basis for dynamic analysis (time interval) for modeling human response, system response to control, and building response, and determine means of integrated inputs for variable time reference models.

2.1.4 Develop efficient means of linking models in a way that is truly flexible and adaptable to innovative building system design strategy analysis. On a collective basis the building energy budgets determined by such models become the national budget for the operation of buildings.

2. INTERACTION BETWEEN THE BUILT AND NATURAL ENVIRONMENTS

2.2 BUILDING FORM RESPONSES TO THE NATURAL ENVIRONMENT

Changes in building form responding to differences in the natural environmental conditions result in modifications of energy demand. The shift to a greater awareness of regionalism in architectural design is a spontaneous manifestation of this tendency. Nevertheless, the factual basis is not well developed or understood.

The following are typical of the problems requiring investigation:

2.2.1 As a continuation of studies on windows, solar gain and daylighting, investigate and develop models noting interaction between heat gain or loss, light gain, and air transfer, as affected by temperature, solar angle and other local environmental conditions.

2.2.2 Develop cost/benefit studies on various devices that affect sun control, light control and insulation such as Rolladen, exterior Venetian blinds and others.

2.2.3 Develop studies comparing building forms whose internal conditions are provided largely through the exterior skin, with buildings with large interior areas whose internal conditions (light, air, temperature, humidity) are provided basically through mechanical systems.

2.2.4 Develop models of analysis for built form at the community level, in order to assess alternative patterns of interaction with the natural environment.

2. INTERACTION BETWEEN THE BUILT AND NATURAL ENVIRONMENTS

2.3 CHANGES IN THE NATURAL ENVIRONMENT RESULTING FROM BUILDING ENERGY USES

This topic is a complex but central issue of energy conservation. By reorganizing the natural environment in communities, cities and regions, human activities can take place. As this process continues, the resources of wide areas (air, water, land) are modified to serve these concentrations. At some point, the intensive use can exceed recoverable conditions and can cause the degradation of the conditions necessary to sustain life in the concentrated area. The control of demand for energy use by the building patterns of communities can have serious ramifications for the natural environment.

For example, New York has created a heat sink of such magnitude that diurnal wind change no longer operates, making it necessary to use mechanical cooling where natural seabreeze cooling formerly occurred.

Some examples of topics to be considered within this area are:

2.3.1 Study energy requirements as they potentially degrade the natural environment.

2.3.2 Study energy requirements for transforming the natural environment to provide infrastructure for cities. (Energy cost of water supply, waste disposal, electric generation and transmission, road network, and other transportation facilities.)

2.3.3 Examine alternative size and density patterns for communities where energy benefits of compaction, reduced transportation, and so forth are maximized in relation to energy required to provide satisfactory conditions.

Category 3: BASIC ENERGY PROCESSES

The underlying scientific basis for much of the technology for energy utilization in buildings and communities comes in large measure from fundamental and empirical research of basic energy processes--heat and mass transfer, energy storage principles, and thermodynamic cycles. The central goal in this research category is to create an enhanced scientific understanding of basic energy processes that can lead to a broadened energy technology base that in turn can lead to more energy efficient buildings.

Advances in basic scientific knowledge in this field could potentially have far-reaching effects in fostering conservation. An improved understanding of thermodynamic cycles of heat and mass transfer, for example, could lead to dehumidification processes or alternatives to heat pumps that, when applied, could save enormous amounts of energy.

While the rewards of this basic scientific research could be large, the risks are also very high. There is no way of knowing now which scientific areas could lead to breakthroughs, and even less certainty as to whether a breakthrough could lead to proprietary products for a group that sponsored such basic research. Privately funded basic scientific research of this type has been, and presumably will be, a rare exception.

Research areas identified within this category are:

3.1 Models of Heat Transfer

3.2 Heat Exchange Technology

3.3 Thermodynamic Processes

3.4 Energy Storage

3.5 Cogeneration in Buildings

3: BASIC ENERGY PROCESSES

3.1 MODELS OF HEAT TRANSFER

A better understanding is required of dynamic, and three-dimensional heat transfer processes in buildings and their component energy using systems. Especially needed is an improved understanding of building systems where dynamic behavior is significantly different from predictions that would result from steady state analysis (for example, passive solar designs, buildings of high mass, and ground contact systems). Finite-element and finite-difference models generally are suited to many of these tasks. Advances in computers makes their use increasingly feasible; however, useful models and analyses are needed.

Development of certain specific three-dimensional, dynamic design analysis programs would be helpful including those involving earth contact building systems, wind sensitive analyses, and analyses of envelope heat transfer sensitive to variation in solar insolation and outside temperature. These programs should be translated into design tools for architects, engineers and builders. Also important will be validation of new dynamic analysis design tools, and standardized test methods for real building and building component monitoring and evaluation.

The following illustrations are examples of projects in this area:

3.1.1 Develop validated algorithms for describing earth contact conditions. Most energy analysis computer programs available today do not include this very important feature in their calculations. A model that includes this condition would have increased usefulness.

3.1.2 Develop and validate dynamic simulation models for predicting energy use in small buildings. Many times a discrepancy does exist when comparing actual data obtained from occupied buildings with the predicted values obtained from existing models.

3.1.3 Improve techniques to model, measure, analyze and test relative and absolute heat flow and air infiltration through building components and envelopes. The vast majority of calculation methods in use today do not address the important differences between varying components such as ceilings and walls.

3.1.4 Examine natural ventilation and convection phenomena in buildings as they relate to and affect the basic principles of heat transfer.

3.2 HEAT EXCHANGE TECHNOLOGY

Heat exchange capabilities of fluids and solid surfaces are understood on an empirical basis, but substantial room for new knowledge may exist, especially in the areas of basic chemistry and physics and in control of heat transfer. Basic research could be productive regarding particle or molecular heat exchange between fluids and solid surfaces (for example, to determine if variations in working fluids, heat exchange coatings, or heat exchange materials could substantially improve performance, especially in temperature ranges applicable to buildings).

A knowledge of modeling and analytical methods exists for empirical consideration of heat exchange performance. However, further research on buildings is required to provide the data to support these models. Other potential beneficial research includes materials research relating to performance and the utilization of materials for heat exchange, and the development and validation of standardized test methods in the technology of heat exchange.

Possible research topics in this area include:

3.2.1 Analyze the effects of various physical stimulants on changing the heat transfer characteristics of glazings. For example, electric current is known to have an impact on glazing.

3.2.2 Improve techniques for measuring, analyzing, and testing in the area of phase change heat exchange technology.

3.2.3 Improve measurement techniques for surface coefficients. The coefficient figures currently in use in many energy calculation techniques could be greatly improved through more accurate measurements in the field.

3.2.4 Conduct research to measure and modify heat gain characteristics of glazing by external devices. Field results on the use of overhangs, horizontal and vertical louvers, and other devices have not been documented sufficiently for use as feedback to improve the design and efficiency of such devices. The practical application and durability of these devices also should be examined.

3.3 THERMODYNAMIC PROCESSES

Thermodynamic principles are well known but the potential for substantial improvement exists in application in the built environment, especially regarding development of alternative thermodynamic cycles, new refrigerants, and chemical or solar assisted devices. While the development work should be in the private sector, public sector support for initial concept development could be important.

Specific research topics to be addressed in this area are:

3.3.1 Evaluate the properties of nonazeotropic refrigerant mixtures as a working fluid for vapor compression cycle heat pumps. (Two fluids are currently being considered; this could be expanded to three.)

3.3.2 Evaluate the properties of nonazeotropic refrigerant mixtures for absorption heat pumps.

3.3.3 Conduct tests to determine the applicability of variable speed AC motors for variable speed compressor drives.

3.3.4 Evaluate Brayton, Stirling and other cycles for more efficient heating and cooling devices.

3.3.5 Evaluate properties of new desiccants and vapor permeable membranes.

3.3.6 Conduct basic research on absorption/desorption dynamics.

3.3.7 Conduct research on ground heat and mass transfer (dynamics of soil moisture, freezing and thawing properties of different soils).

3.4 ENERGY STORAGE

The application of energy storage techniques in buildings could reduce energy consumption and lower peak energy demands as well as facilitate the use of alternative or renewable energy sources. Buildings, during their yearly operational cycle, often have periods when they have to dissipate excess thermal energy. Alternatively, buildings may have periods when they cannot use all the energy available to them. This may occur in the evening with low electric demand. The advantages of being able to store excess heat gained in the summer for heating in the winter are obvious, as are the advantages of storing electricity during off-peak periods for meeting peak period requirements--energy that would otherwise be wasted could be used.

The basic scientific principles that underlie the broad range of thermal, chemical, biological and mechanical energy storage are known, but much work needs to be done to refine and apply these principles in an energy and cost efficient manner in buildings.

Some promising research opportunities in this area include:

3.4.1 Develop concepts for new or improved energy storage processes and materials. Investigations could focus on improving phase-change materials, developing thermochemical processes, producing new chemicals for high-density energy storage, improving battery and other forms of electrical energy storage, improving biological energy conversions and storage processes, developing methods for energy storage and retrieval from ground water aquifers or abandoned mineshafts, and integrating energy storage into building architecture.

3.4.2 Develop modeling techniques for long-term storage of thermal energy. These models must accommodate such problems as stratification, time lags and thermal losses. Because of varying earth characteristics, ground storage presents some special modeling problems that need to be resolved.

3.4.3 Develop methods of design and synthesis to size and integrate energy storage technologies effectively and reliably with other building systems.

3.5 COGENERATION IN BUILDINGS

Cogeneration in buildings is the combined production of useful thermal energy and electricity in one process. Though theoretically advantageous, cogeneration systems in buildings, especially small buildings, have only recently started to achieve success. While cogeneration systems have been in place for years at the community and industrial levels, perhaps the most promising avenue for advancement is cogeneration systems for small buildings and residences. Research could provide an understanding of alternative thermodynamic processes and new materials and systems that could facilitate this technology in overcoming the problems of high initial cost and low durability.

Typical research topics may include:

3.5.1 Develop methods of testing for long-term wearing characteristics of cogeneration systems.

3.5.2 Perform exploratory research on new thermodynamic cycles and new materials for cogeneration systems.

- o Under 3.5.2, perform modeling and analyses of new alternative thermodynamic cycles.

3.5.3 Evaluate possible use of community or sub-community cogeneration.

Category 4: ENERGY USE AND CONTROL IN BUILDINGS AND COMMUNITIES

Most buildings and community systems that exist today have been designed based on fairly simple and straightforward empirical relationships, as discussed under Category 3. Heating and cooling systems and their component parts, for example, are designed and specified primarily on the basis of expected peak-load energy conditions. The operation of components and systems is seldom considered on a dynamic and interrelated basis. If dynamic interrelationships can be considered successfully, the potential exists for significantly increasing conservation of energy. This will require development of more sensitive and sophisticated means for analyzing energy use in buildings and communities. Needed are variables that are dynamic in nature, that are sensitive to geometry and configuration, that are sensitive to microconditions rather than only macro or average conditions, and that consider partial loads and interrelationships between systems. While several of the available mainframe computer programs do attempt this kind of modeling, more work is needed to improve and expand their capabilities.

The research areas within this category are directed toward gaining a working understanding of design variables and their interrelationships that until now, have been ignored or have been treated on only an intuitive basis. The motivation is that it has been demonstrated repeatedly in passive solar and other types of buildings that the use or control of design attributes such as siting, mass, color, orientation and sizing can bring dramatic energy savings, while at the same time produce a built environment that better meets the needs and desires of people. However, adequate quantitive means do not exist for reliably and effectively utilizing all design and operational options. Research in this category needs to produce a better understanding and definition of the range of system variables that is now pertinent, to quantify interrelationships between factors, and to develop analytical models. Research is also needed to develop design methods and tools that can take advantage of this new level of knowledge, but can do so without making the design process inordinately complex, time consuming or expensive.

The areas that have been structured under this category are:

4.1 Whole Building Energy Processes

4.2 Energy Control Strategies

4.3 Embodied Energy: Buildings and Communities

Category 4: ENERGY USE AND CONTROL IN BUILDINGS AND COMMUNITIES

4.4. Intermittent and Localized Energy Systems

4.5 Moisture Control

4.6 Illumination of Buildings and Communities

4.7 Characteristics of Building Envelope Systems

4.8 Retrofit of Existing Buildings

4: ENERGY USE AND CONTROL IN BUILDINGS AND COMMUNITIES

4.1 WHOLE BUILDING ENERGY PROCESSES

Human activity in buildings occurs amidst a backdrop of complex energy forces. While the common sources of building energy are purchased such as oil, gas and electricity, environmental factors such as sun and wind, and the "hidden" sources of energy such as heat from equipment have a significant effect on energy performance.

Improvements can be made in understanding the joint dynamic workings of the whole building's energy producing and using systems. These improvements can be made for all building types and systems. A better understanding of whole building energy processes can lead to improved energy efficient design.

Currently there is little verifiable data on actual energy use in buildings. Any data base should be able to utilize the dynamic status of buildings. A better understanding is needed where steady state performance poorly represents dynamic behavior, as in passive solar design features. Analytical tools that are sensitive to the performance differences caused by dynamic processes are needed both for highly accurate research analyses and for simplified forms of analyses.

Examples of research topics:

4.1.1 Undertake research to determine how best to gather, classify, access and use data on total building energy use.

4.1.2 Develop a better understanding of natural convection phenomena in rooms and interior spaces. Further knowledge needs to be developed on multi-room transient analysis of buildings. Models should be developed to test the effects of one room's influence on another room.

4.1.3 Develop simple, low-cost, front end design tools for whole building energy analysis. Criteria for these should be developed based on user analysis for format requirements and other needs.

- o As a subset of 4.1.3, develop simple, interactive dynamic analysis models to be used as tools for predesign energy use analysis. Existing complex computer simulation programs can be condensed into useful tools.

4.1.4 Develop methods and techniques for integrating energy intensive appliances with other building systems.

4.1.5 Examine the impact of "hidden" sources of energy on whole building energy performance for various building types. "Hidden" energy in a building is energy that is typically not accounted for in standard calculations, such as the heat produced by large computers or by treatment processes of community waste.

4.2 ENERGY CONTROL STRATEGIES

Energy controls for buildings are concerned with coordinating the functions of the energy consuming and producing systems in a building with each other and with the demands of the external and internal building environment so that energy is used in as efficient a manner as possible. Work in this area has resulted in the development of a whole range of software and hardware technology for controlling energy use in buildings. Future research needs to be directed towards developing techniques and systems to monitor, measure and interpret the energy related variables impacting a building in the dynamic mode and then use this data to adjust the energy systems in that building so that they minimize energy consumption.

Typical research topics include:

4.2.1 Perform modeling of multi-variable energy control strategies to develop an understanding of how these control strategies would be integrated, how the strategies would respond to varying operating and environmental conditions, and how the occupants would interface and respond to them.

4.2.2 Based on the model work proposed in 4.2.1, undertake development of optimum control algorithms and energy system configurations. These energy control strategies could be combined with energy load strategies that may be developed under 5.2, "Community Energy Processes, Use, and Systems." Private sector developments should pick up concepts and implement than in the market place.

4.2.3 Develop testing and evaluation methodologies for static and dynamic control performances of buildings and systems.

4.2.4 Develop field validation methods for control strategy models.

4.3 EMBODIED ENERGY: BUILDINGS AND COMMUNITIES

As new buildings and communities become increasingly energy efficient from an operating point of view, the energy expended prior to their operational phase, defined here as embodied energy, takes on greater significance. In a contemporary office building, for example, the embodied energy can readily approach 1 million BTU per square foot of floor area. If the useful life of the building is 20 years, then it will have required 50,000 BTU per square foot to create the building. Among other things, this suggests that increasing attention be paid to reuse of existing buildings.

This area is concerned with the embodied energy in buildings and communities, the energy consequences of alernative building choices and the long-range implications of these activities. Some studies have been conducted that identify in great detail the purchased energy that is required by the construction industry for the entire economy, for various building sectors, for individual buildings and for the materials and assemblies used in building. This embodied energy accounts for all energy required to produce an end product, from the extraction of raw materials to all steps in the manufacturing processes, and includes prorated energy costs for transportation, plants and equipment, and facilities for administration and marketing. The data show that over ten percent of total U.S. purchased energy is used by the construction industry.

There is also a need to assure that information available concerning embodied resources is integrated with design methods and decision making at various levels in the building and community development processes. To the degree that the value of embodied resources is not reflected in the first costs of building and development, it is important to recognize that appreciable returns on research and development efforts related to embodied resources may not soon be realized by individual builders and developers. This suggests an appropriate area of federal expenditure, as the return to society generally will be great.

Among the topics that could be explored in this area:

4.3.1 The available data on embodied energy in buildings is based on Commerce Bureau of Economic Analysis data from 1967. More recent data from 1972 are available. Updating the information to this later data base will make it dynamic, and will identify directions of change in the building industry.

4.3.2 Parallel to the modeling of the total energy use required for the operation of buildings, a study is required to determine the amount and kinds of energy needed to provide new buildings and replacements.

4.3.3 Expand the conceptual base of basic scientific developments that would lead to reductions in the amount of embodied energy used to produce buildings and community systems while maintaining their desired performance characteristics.

4.3.4 Develop interactive models that would project alternative embodied resources for various building construction types and land use planning approaches.

4.3.5 Assess the resources embodied in various forms of physical development at the community and urban scales.

4.3.6 Explore alternative methods (including existing practices) for resource valuation. Define what these new methods might provide in the way of analytical tools.

4.4 INTERMITTENT AND DISTRIBUTED ENERGY SYSTEMS

Substantial gains in energy efficiency may occur if heating, cooling, lighting, and other forms of space conditioning are supplied only when and where needed, and only in amounts necessary for the purpose at hand. Current building systems are seldom designed to take advantage of this concept, except in terms of very gross environmental adjustments.

At both the building and community levels research would be beneficial that presses our ability to provide distributed, decentralized systems that are designed to operate only intermittently and at levels suited to the requirements of the moment. This approach is an integral part of making buildings and community systems responsive to their locations and the demands of use placed upon them.

It is commonly held that increased user control over energy systems is to be avoided; environmental conditioning systems in all but the smallest of buildings routinely are designed on the assumption that occupants should have less, rather than more, involvement in determining ambient conditions. Great promise exists in an alternative approach, which would require positive actions or decisions of users in determining environmental conditions. The concept of intermittent and highly localized energy systems is closely linked with research into user practices and environmental responses, as well as the overall energy economy of building operation. The pursuit of this area would conceivably lead to systems that would not provide ventilating air until users decided it was needed, heating and cooling would be supplied only upon demand by users. As an example, subway escalators that run only when people are present, a common approach in European cities, can be designed to operate only on active demand. (see the associated ideas of Section 1.3)

Among the topics that would be researched in this area are:

4.4.1 Develop models of building energy performance that would be capable of assessing the performance of demand based, distributed energy systems.

4.4.2 Develop design estimating methods and other design oriented tools that would assist in applying this approach to various generic buildings and community systems.

4.4.3 Develop design strategies that combine large-zone, constant condition heating, cooling and ventilating systems with smaller, spot-zoned devices and systems.

11-221 O—82——11

4.5 MOISTURE CONTROL

The concept of moisture control used here includes the problems of moisture in building components as well as the interrelated concerns of humidity control for human comfort and health. Moisture problems, especially in structural components and insulation, can lead to problems of materials' deterioration as well as reduced energy performance.

A better understanding is needed about the impact of natural transport of moisture through building materials, especially insulation and structural components. Recognizing that moisture in buildings is a key problem, research should be undertaken to learn more about the effects of moisture on new materials and the relationship of moisture to human comfort issues.

Human comfort is affected by humidity conditions. Alternatives to conventional systems of humidity control such as rechargeable desiccants can be identified and may have the potential for significant energy savings.

Examples of research topics in this area are:

4.5.1 Develop a better understanding of the energy requirements for recharging desiccant materials.

4.5.2 Develop models that reveal more about moisture transport through building materials.

4.5.3 Develop better information for building designers about moisture transport and humidity controls under specific climate conditions. Materials and methods should be developed to assist designers with this area of concern.

4.5.4 Develop methods to measure, test and evaluate the effectiveness of vapor retardants.

4.5.5 Develop an analytical model for the effective dissipation of the moisture generated in buildings in relation to climatic, construction, design and occupancy factors, air infiltration and ventilation, and building site.

4.5.6 Prepare and publish guidelines for the control and management of moisture in buildings in a format suitable for designers, builders, and managers.

4.6 ILLUMINATION IN BUILDINGS AND COMMUNITIES

Design of the luminous environment is crucial to energy questions in the built environment. At virtually all levels in buildings and communities lighting is a major requirement, linked to safety, health, productivity, and the very functioning of environments.

An abundant form of solar energy reaches us as light, yet this is a frequently overlooked and certainly underused resource. In buildings there is a basic need to better integrate sunlighting systems with other kinds of lighting. In larger contexts--for roads, sidewalks, public spaces and commercial facilities--there is a need to achieve this same integration and to apply the "task-oriented" approach that has achieved some currency in contemporary buildings.

The relationships between required illumination levels and the technology of lighting need to be investigated. Research also is needed to improve methods of lighting control and assessment of available daylighting resources.

Among the research topics in this area are:

4.6.1 Develop correlations between data on available insolation (now generally known for most areas of the country) and possible illumination levels.

4.6.2 Develop instrumentation, sensors and measurement devices for evaluation of physical models of buildings and groups of buildings.

4.6.3 Explore the potential of alternative technologies for producing and transmitting light for possible application in buildings and communites.

4.6.4 Develop information on the reflective properties of various building materials, glazings and coatings.

4.6.5 Develop new methods for use by designers in integrating natural lighting with other lighting systems, and for relating these systems to overall building energy performance.

- o As a subset of 4.6.5, develop generic design strategies for deep penetration of sunlight to interior spaces and controls for such strategies.

4.7 CHARACTERISTICS OF BUILDING ENVELOPE SYSTEMS

Among the scientific and technological factors limiting improvement of the energy efficiency of buildings is a lack of detailed knowledge about how they respond to external and internal changes in environmental and use conditions on a continuing basis. A better understanding is needed of the characteristics of building envelope systems, especially their dynamic behavior. This information will lead to more accurate predictions of how buildings will perform under different conditions and will aid in development of improved control strategies (Section 4.2).

Potentially fruitful research topics include:

4.7.1 Develop laboratory and field testing procedures for building envelope systems to establish and document basic properties and dynamic modes of behavior which currently are inadequately understood.

4.7.2 Develop dynamic analytical methods for building materials, composites and envelope systems to define what constitutes good and bad dynamic performance.

4.7.3 Investigate the development of new building materials, composites and systems for building envelopes that have good dynamic response characteristics.

4.7.4 Develop test methods to carry out the measurements required in some of the preceeding suggested research topics in this area.

4.8 RETROFIT OF EXISTING BUILDINGS

More than one-third of the energy expended in this country is consumed by existing residential and commercial buildings, and it is estimated that 40 percent of this energy is wasted. The potential for energy savings through retrofitting existing buildings is tremendous, especially when one considers that 80 percent of the buildings that will be in use in the year 2000 are in existence today.

The process of retrofitting a building involves diagnosing the problems and areas of opportunities, designing, evaluating and implementing the solutions, and evaluating the results. While research has been undertaken on all parts of this process, especially for residential buildings, efforts are still needed to improve the diagnostic techniques and hardware. Improvement of these techniques and hardware, particularly at the commercial building scale, will assist designers and engineers in making retrofit decisions with a reasonable degree of confidence.

While it generally is recognized that the nontechnical barriers to retrofitting existing buildings are significant (for example, financial, regulatory and educational barriers), specific technical research is needed to provide the necessary techniques and tools.

Some examples of research in this area are:

4.8.1 Develop and validate simpler and more accurate diagnostic tools. Existing modeling techniques are generally inadequate for creating a framework for consideration of retrofit options.

4.8.2 Develop better test methods to assess the in-place energy performance of buildings and their components.

- o As a subset of this activity, perform analyses on the thermal characteristics of materials under exposed conditions over many years.

4.8.3 Develop a uniformly consistent data base of building energy performance based on field experience rather than laboratory results.

4.8.4 Conduct evaluations of the in-place performance of retrofit measures in order to minimize the differences between predicted and actual energy performance.

Category 5: COMMUNITY INFRASTRUCTURE AND ENERGY CONSERVATION

This category addresses fossil fuel and energy conservation issues at the community or urban level. One important aspect of this subject is hardware systems, characteristically owned and operated by local governments or utilities, and are often referred to as the infrastructure (for example, the systems for supplying energy and water, and removing waste from a total community as contrasted to a single building). In many communities the infrastructure systems were put in place more than seventy years ago. As a result the energy efficiency of these systems is impaired by the lack of maintenance or repairs--clearly a governmental responsibility. Even in newer communities the same basic hardware systems, developed 100 years ago, still are being installed.

Aside from pure hardware issues, this category also addresses the more general issue of energy flow into and within communities, and the related issues of consumption, conservation, and possible planning strategies. The opportunity for innovation in this category is enormous, but may be constrained by the many political and institutional barriers that can slow down or block the introduction of major new ideas into ongoing local government operations.

The research areas included in this category are:

5.1 Water and Waste Water Systems

5.2 Urban Solid Waste Systems

5.3 Community Energy Processes, Use and Systems

5: COMMUNITY INFRASTRUCTURE AND ENERGY CONSERVATION

5.1 WATER AND WASTE WATER SYSTEMS

The processing and delivery of potable water and the removal and treatment of wastewater and sewage are services that require large amounts of energy. New technologies and methods with respect to water conservation, heat reclamation and low energy use need to be examined. There is a need for basic research particularly where chemical or biological processes can substitute for current energy intensive processes. Alternative methods for water and wastewater treatment, use and reuse, distribution, and disposal need to be assessed with regard to energy conservation at both the community and building level. For example, energy use for pumping is increasing because groundwater supplies are being diminished and are not being replenished.

The following are examples of research topics that can be considered in this area:

5.1.1 Conduct research to develop new materials to ease the flow of water through pipes to reduce the energy used for pumping (for example, special interior pipe surfaces to reduce friction).

5.1.2 Develop new concepts which would encourage conservation of water use in buildings and the energy used to heat that water.

5.1.3 Develop methods for heat recovery from waste water.

5.1.4 Analyze the feasibility of injecting low-grade heat into main water conduits serving municipalities. This heat typically would come from electrical generating power plants.

5.1.5 Conduct research on waste treatment processes to facilitate underground disposal.

5.1.6 Model and develop storm water management systems to reduce runoff, replenish ground water supplies and reduce stream pollution in new building developments.

5.2 URBAN SOLID WASTE SYSTEMS

The relationships between municipal solid waste and energy production need to be examined with regard to improved processing techniques, environmental effects and energy production technologies. Better technologies for handling, separating and processing municipal waste need to be developed. For example, new urban waste energy systems may use biological enzymes to produce gases from waste materials. Research to better understand this process and others is needed. In addition, improved techniques for processing urban waste need to be examined especially with regard to the interface of such systems with the existing urban infrastructure of waste disposal, and systems for treatment at the source. Other beneficial research includes the development of improved methods for the design of economical urban and individual waste systems, followed by the development of methods to measure and test the environmental effects of urban waste systems on the community.

Examples of possible research include:

5.2.1 Develop methods of reducing the volume and/or mass of urban solid waste. This could ultimately lead to a much reduced energy load in handling and processing this waste.

5.2.2 Develop methods of waste treatment at the source of its generation. The current technique of removing waste to a central processing point is extremely energy intensive. By treating the waste at the source (i.e. at the building rather than community level) much energy can be saved by eliminating the vast amounts of energy used to transport the waste.

5.2.3 Conduct research into nonpolluting disposal systems.

5.3 COMMUNITY ENERGY PROCESSES, USE AND SYSTEMS

The physical organization and relationships of the buildings and other facilities in a community to each other, to the people who use them, and to systems that supply their energy and other resource requirements may have important influences on the amount of energy consumed. Currently, most urban planning is done with little consideration for these potential impacts. This is not surprising because the flow of energy within communities and regions and the interrelating impacts are not very well understood.

This research area proposes improving the base of knowledge on the flow of energy within communities and regional areas and utilizing this information to improve existing strategies, and to develop new strategies, for dealing with these flows.

Possible research topics include:

5.3.1 Develop the socio-economic rationale to explain how human living patterns and technology work together to impact energy consumption.

5.3.2 Clearly map patterns of energy flow within communities--the supply, distribution, storage and use--and characterize and quantify the community factors that influence energy use.

5.3.3 Examine how new energy technologies and applications may affect the physical form and spatial/functional layout of buildings and community facilities.

- o As a subset of this topic, develop prototype community layout schemes that consider the quality and temperature of energy flowing into and out of buildings as well as other more traditional functional relationships.

5.3.4 Develop strategies and methods for minimizing waste in community energy flows.

5.3.5 Develop design techniques for testing and evaluating strategies for designing and managing community energy flows.

Other subjects that could be addressed in this research area are solar zoning and community design, the improvement of micro-climate with vegetation, and other space planning techniques.

Category 6: RESEARCH INFORMATION DISSEMINATION AND TECHNOLOGY TRANSFER

The ability to introduce innovative concepts and methods into the processes of designing, producing, and managing the built environment has a direct relationship to the success of any conservation effort. While Category 1 which concerns user interactions is the driving force behind this agenda, Category 6 must be the final culmination of any efforts of the previous five. Unless successful research and development efforts are communicated directly to the planners and implementors of the built environment, the results of research may remain unused.

The building industry is diffuse and fragmented; its participants have diverse backgrounds and needs, and mostly limited resources. The building industry is characterized by low levels of capital and decentralized sources of funding. Because of these factors, traditional communication theory may not be well-suited to the needs of the industry. A research effort should be devoted to the development of the science and theory of communication between the research and application areas within the industry. It also seems appropriate to have all government sponsored research linked to effective dissemination of results to those who could benefit from such information.

Support for effective knowledge dissemination and the utilization of existing research can produce major benefits to the building community in general. Such support often can be as effective and produce as highly visible results as allocating resources toward new areas of research.

Research areas related to this category are:

6.1 Communications Methods and Requirements

6.2 Design Integration Methods and Requirements

6: RESEARCH INFORMATION DISSEMINATION AND TECHNOLOGY TRANSFER

6.1 COMMUNICATIONS METHODS AND REQUIREMENTS.

With rapid changes in the technology and methods of communicating, there is a major opportunity to explore ways to facilitate the flow of information among the various participants and organizations involved in designing, making, managing, and using the built environment. The inadequate flow of knowledge, user requirements, tools of analysis and synthesis, and data among disciplines, research areas, research institutions, and professionals can easily freeze the state-of-the-art of any development. In the development of energy conservation methods and products for buildings and communities there is a clear need for integration of the design activities in order to achieve wider use of nontraditional means. Transdisciplinary concepts often are developed more easily if the effort to understand users' needs and the satisfactions of their well-being is tied to new methods of communications such as computer-based systems. The existing institutional constraints are removed more easily when an entirely new medium beyond the written words of specifications, regulations, and methods of analysis and synthesis is introduced. The use of simulation in computer-based methods is an example of one way to overcome the traditional fragmentation of design results into decisions made by each of the existing professional disciplines.

Communications-based research topics in this area include:

6.1.1 Develop evaluation methods and design synthesis tools that are derived from computer-based concepts. This work can be done by the federal agencies who are responsible for in-house design and construction programs as a means of improving their own operations. The conceptual basis for these new tools then can be assimilated by the private sector companies who provide software support for professional firms in the private sector, as long as the communications links between federal agencies and the private sector are kept open.

6.1.2 Develop means of interrelating the traditional disciplines of HVAC design, lighting design, architectural design and interior space design in a manner which is transdisciplinary. The use of computers would seem to offer the technological base for this development. The financial risk of achieving successful development (as compared to the initial costs of software) is likely to be so high as to preclude private sector initiatives at this time.

6.1.3 Develop a better understanding of how mass media can be used to communicate with users their options for energy conservation in their private and organizational settings.

6.2 DESIGN INTEGRATION METHODS AND REQUIREMENTS

In all systems that are designed and produced by human effort the questions and problems that lie at the interface between the components of the system are always the most interesting and the most challenging. When a community is designed conceptually it may be the work of a planner, an urban designer and a developer. However, as the community actually begins to take shape, and as it grows over time a host of other professionals, organizations and institutions that interact in satisfying needs such as transportation, utilities, buildings, communication systems, waste management and public safety become involved. The institutional designs for providing the residents of the community with health care, educational programs, recreation, work and living spaces are even more complex. The interactions of the "hardware" performance capabilities installed in the community and the "software" performance requirements for effective institutions are seldom studied.

While the problems and opportunities are ones of local government, the methods and tools of analysis can be utilized by all governments, and, as a result, seem to represent a logical program for federal support. Once such tools of analysis and synthesis have been created, the first few applications (or demonstrations) of their use also would seem to be a logical program for federal support. When the methods of analysis and synthesis have been tested and proved to be effective they can pass into the literature and practice of local governments and their professional consultants.

Research and development topics in this area include:

6.2.1 Develop tools of analysis at the level of total communities in order to enable local governments to make trade-offs between alternative hardware systems performance and desired institutional programs.

6.2.2 Study ways of introducing energy conserving methods that move across traditional boundaries of community organization (for example, the trade-offs between transportation and communications in educational programs or work settings).

- o As a subset of this topic also explore the means of gaining the cooperation of traditional craft-based union groups to allow the introduction of innovations that lie at the interface between existing ways of designing or building.

APPENDIX A: ANNOTATED BIBLIOGRAPHY

Achenbach, P. R. (ed.) The National Program Plan for the Thermal Performance of Building Envelope Systems and Materials. Oak Ridge National Laboratory, Oak Ridge, Tennessee, Draft Report, September 1981, 133 pp.

Comprehensive and detailed identification and description of research needs related to building envelopes. The majority of research needs identified focus on the years until 1986.

AIA Research Corporation. Energy: A Challenge to Community Growth (unfunded research proposal to the U.S. Energy Research and Development Administration). Washington, D.C., March 1976, 80 pp.

An outline of a framework within which the energy using elements of community infrastructure may be seen and examined, with discussion of opportunities for successful intervention.

American Physical Society. Efficient Use of Energy: A Physics Perspective. Philadelphia, Pennsylvania, January 1975, 210 pp.

The results of a summer study on the technical aspects of efficient energy use, concentrating on needs and opportunities in buildings, transportation and community systems. Represents views of physicists concerned with making existing systems more efficient.

Association of Energy Engineers, Directory of Technical Magazines and Directories. AEE Energy Books, Atlanta, Georgia, 1981.

A comprehensive listing of magazines and directories in the energy field with statistics about cost, renumeration for authors, circulation.

Battelle Columbus Laboratories, Energy Information Resources. American Society for Information Science, Washington, D.C., 1975, 207 pp.

Describes a wide variety of energy information resources and their fields of coverage. Conservation related research for buildings and

community systems is not described in great detail.

Booz, Allen & Hamilton, Inc., An Assessment of Passive and Hybrid Solar Energy Systems. For U.S. Department of Energy, Washington, D.C., Draft Report, February 1981.

Assesses the readiness of passive and hybrid solar systems for more widespread use in buildings. Identifies problem areas that require further research. Concluded that only residential passive heating systems are ready now for wide use.

Commoner, Barry. The Politics of Energy. Alfred A. Knopf, New York, NY, 1979, 101 pp.

A highly opinionated but nonetheless technical assessment of needs for different approaches to building and developing communities, including extensive critiques of past and present federal policies in these areas.

Comptroller General of the United States, Greater Energy Efficiency can be Achieved through Land Use Management. General Accounting Office, (EMD-82-1). December 21, 1981.

Another useful reference pertinant to improved planning techniques.

Energy, Mines and Resources Canada, Energy Conservation in Office Buildings: Review of Canadian and U.S. Studies, Surveys, Programs, and Publications. Energy, Mines and Resources Canada, Conservation and Renewable Energy Branch, Ottawa, Ontario. Publication #2f, 1979, 1900 pp.

While not related directly to identification of energy research needs, this comprehensive directory indicates the state-of-the-art in recent research and application in this area of building energy conservation.

Energy Research and Development Administration. Buildings Conservation Program Approval Document, Executive Summary. Washington, D.C., 1975, 40 pp.

A further refined and developed version of several predecessor documents, containing a comprehensive rationale for the ERDA programs related to buildings and community systems and many explicit research objectives.

Federal Energy Administration. Five Year Program Planning Document for End Use Energy Conservation, Research, Development and Demonstration. PB240406, Washington, D.C., June 1974, 238 pp.

The first comprehensive federal plan related to energy conservation, encompassing the efforts and views of 16 federal agencies. It sets

forth research and development priorities, many as yet unfulfilled.

Ford Foundation/Resources for the Future. Energy the Next Twenty Years. Ballinger Publishing Company, Cambridge, Mass., 1979.

Nineteen experts criticize recent government energy policies in a major policy study supported by the Ford Foundation. Research needs are discussed.

Holloman, J. Herbert et al. Energy Research and Development. Ballinger Publishing Company, Cambridge, Mass., 1975.

Collected papers prepared for the energy policy project of the Ford Foundation. The need for building energy research is discussed along with general suggested directions and priorities. Specific research recommendations are not extensively covered.

National Academy of Engineering. U.S. Energy Prospects: An Engineering Viewpoint. Washington, D.C., 1974, 141 pp.

A comprehensive report on the recommendations of the NAE Task Force on Energy, which was influential in shaping early federal energy conservation efforts. Extensive discussion of research and development needs and priorities.

National Advisory Council on Research in Energy Conservation. Energy Conservation Research: A Key to Resolving the National Energy Dilemma. Washington, D.C., December 1975, 50 pp.

A report of findings from a year-long study concerned with the needs and opportunities for energy conservation research, giving special emphasis to buildings.

Oak Ridge National Laboratory. Assessment of Building Diagnostics, Oak Ridge National Laboratory, Oak Ridge, Tennessee, July 1981, 108 pp.

This assessment addresses the building diagnostic requirements for in-situ or field measurements on energy consumption in conditioned spaces and on heat gain and loss in residential and non-residential buildings. The diagnostics program plan that is included contains the following elements:

1. Envelope Thermal Performance Evaluation Techniques
2. Efficiency and COP of HVAC Systems
3. Large Scale No-Visit Surveys
4. Whole Building Periodic Audits
5. Electronics Technology Transfer
6. Energy Performance Monitoring in Buildings
7. Interior Environmental Monitoring
8. Research and Development
9. Information Dissemination

Organization for Economic Cooperation and Development. Energy Research and Development. Organization for Economic Cooperation and Development, Paris, 1975.

Discusses broad fields of energy research required. Notably it states on page 89 that "it must also be borne in mind that science and technology probably contribute less in this field (buildings) than in the production of energy."

Press, Jacques Cattell (ed). Energy Research Programs. R. R. Bowker Company, New York, N.Y., 1980.

Massive compilation of private and public organizations involved in various aspects of energy research. Provides brief indications of the areas of research in which listed organizations are active.

Public Affairs Clearinghouse. Energy: A Guide to Organizations and Information Resources in the United States. Second Edition, Public Affairs Clearinghouse, Claremont, California, 1978, 221 pp.

Chapters 8-10 deal with organizations involved in the interrelated areas of energy conservation, environmental quality and consumer protection.

Schurr, Sam H., et al., Energy in America's Future: The Choices Before Us. published for Resources for the Future by John Hopkins University Press, Baltimore, 1979.

Solar Energy Research Institute. A New Prosperity: Building a Sustainable Energy Future. Brick House Publishing, Andover, Mass., 1981, 450 pp.

Perhaps the most comprehensive assessment ever completed on the potential for energy conservation and renewable energy resources, with a major section on buildings and communities. Originally prepared for the House Science and Technology Committee and Energy and Commerce Committee. Contains a range of recommendations on research and development priorities.

Steadman, Philip. Energy, Environment and Building: A Report to the Academy of Natural Sciences of Philadelphia. Cambridge University Press, New York, N.Y., 1975, 287 pp.

A thorough examination of the needs and opportunities for energy conservation in buildings, emphasizing new technologies for the use of renewable energy sources and for saving energy. One of the first major assessments of development potential for buildings.

Sullivan, Thomas F. P. (ed). Energy R & D, Present and Future. Proceedings of the First Annual Energy R & D conference, Government Institutes, Inc., Washington D.C., 1974.

Provides a variety of papers related to energy R & D. Papers are related to conservation in buildings and community systems.

U.S. Department of Energy, and Brookhaven National Laboratory. Building Energy Controls Assessment. Second draft.

Prepared as a guide for planning efforts by the Department of Energy in building energy controls. This assessment identifies both current and emergency issues in the controls field, many of which could be addressed by research.

U.S. Department of Energy, Buildings Division. Numerous internal planning and budgeting memoranda and unpublished reports from contractors and national laboratories concerned with ongoing research activities.

U.S. Department of Energy, Technical Information Center. Information Resources in the USA on New and Renewable Energy. U.S. Government Printing Office, Washington, D.C., June 1981, 80 pp.

This comprehensive directory prepared for a United Nations conference details who performs research,, how the results are distributed, and lists libraries, offices, data bases, and directories.

U.S. Department of Energy. Passive Commercial Buildings SubProgram Multiyear Plan. Final Draft, U.S. Department of Energy, December 8, 1980.

Identifies five-year objectives, strategies, proposed activities and schedules for a DOE program in commercial buildings.

U.S. Department of Energy. Preliminary Plan for Fiscal Year 1982 Programs Related to Passive and Hybrid Solar Heat Technologies. Washington, D.C., August 1981, 280 pp.

A comprehensive and unimplemented plan for development of solar heating and cooling technologies for buildings, with extensive discussion of research needs and recommended funding priorities.

World Energy Engineering Conference. Energy Utilization. in Proceedings, AEE Energy Books, Atlanta, Georgia, 1051 pp.

A collection of state-of-the-art applications for improving plant and building energy efficiency and applying alternative energy resources by 60 energy experts.

11-221 O—82——12

APPENDIX B: BIOGRAPHICAL SKETCHES OF COMMITTEE MEMBERS

COMMITTEE ON ENERGY CONSERVATION IN BUILDINGS AND COMMUNITY SYSTEMS

Chairman:

RICHARD C. JORDAN, Professor and Associate Dean, University of Minnesota, Minneapolis, Minnesota. Dr. Jordan is currently an Associate Dean of the Institute of Technology. He was also Head of the Department of Mechanical Engineering, and Head of the School of Mechanical and Aerospace Engineering. He has served on numerous national and international committees and boards, and has published extensively in the fields of mechanical engineering, particle technology, solar energy utilization, education, heat and mass transfer, air pollution and air filtration, and environmental control. He is a Fellow of the American Society of Mechanical Engineers, a Fellow, Presidential Member, and past president of the American Society of Heating, Refrigerating and Air-Conditioning Engineers, and a member of various other professional societies and councils. Dr. Jordan is a registered professional engineer and holds a Bachelor of aerospace engineering, an M.S. in mechanical engineering, and a PhD in engineering from the University of Minnesota.

Members:

MICHAEL G. GRIFFITH, Director, Research and Development, Owens-Corning Fiberglas Corporation, Technical Center, Granville, Ohio. Dr. Griffith is the director of research and development for all the corporation's technical activities. He has previously directed labs dealing with insulation technology and exploratory research. Dr. Griffith has also held various research and development positions with the DuPont Company, specializing in textile fibers. Previous to a year of postdoctoral research at the University of Minnesota, he received his B.S. in chemical engineering from Northwestern University, and his PhD in physical-organic chemistry from Louisiana State University.

JEROLD W. JONES, Associate Professor of Mechanical Engineering, University of Texas, Austin, Texas. Dr. Jones is an Associate Professor and Coordinator of Conservation Studies at the Center for Energy Studies.

He has also served as a consultant to Congress, federal and state agencies, professional organizations, and private companies on building energy requirements, energy conservation, and energy management. He has published technical articles and reports in these subject areas as well as in heat transfer and gas dynamics. Dr. Jones is a member of the American Society of Heating, Refrigerating and Air-Conditioning Engineers, has been a member of several of their national committees, and served as a local chapter officer. He holds a B.S. in mechanical engineering from the University of Utah, an M.S. from Stanford University, and a PhD from the University of Utah.

PRESTON E. McNALL JR., Chief, Building Physics Division, Center for Building Technology, National Bureau of Standards, Washington D.C. Dr. McNall directs the efforts of a division involved in the development and implementation of design standards, and evaluation, test and measurement methods for building thermal envelope systems, and passive solar heating and cooling systems. He is also responsible for the development of similar criteria for building illumination and acoustical performance, and has directed research on standards in mechanical, thermal, plumbing, and electrical engineering. Dr. McNall is the author of numerous technical papers published in the ASHRAE Journal, ASHRAE Transactions, Building Research and Practice, and other publications. He is a member of the American Society of Mechanical Engineers, the American Society of Heating, Refrigerating and Air-Conditioning Engineers, and has served as a member and chairman of many ASHRAE national committees. Dr. McNall was a professor at Kansas State University, and Head of their Mechanical Engineering Department. He is a registered professional engineer, and holds a B.S. in mechanical engineering from the University of Wisconsin, and an M.S. and PhD in mechanical engineering from Purdue University.

GERSHON MECKLER, Partner and Director of Engineering Design, Haines, Lundberg, Waehler, New York, New York. Mr. Meckler's work has focused on energy integrated design and cost analysis, and he has been issued more than 30 patents relating to building energy conservation and systems. He has served as a consulting engineer to the Owens-Corning Fiberglas/U.S. Steel Consortium for the General Services Administration's prototype building systems project and has been responsible for the design of the solar energy heating and cooling system for the U.S. National Fish Health Research Laboratory, the environmental system incorporating cogeneration for the Science Museum of Virginia, and the solar energy cooling and dehumidification system for the D.C. Veterans Hospital. Mr. Meckler currently is chairman of the Energy Conservation Committee of the Council on Tall Buildings and Urban Habitat, and the Solar Heating and Cooling Technical Committee of the International Solar Energy Society. He is a registered professional engineer and received a B.S. in engineering physics from the Pennsylvania State University.

RICHARD G. STEIN, FAIA, Principal, The Stein Partnership, New York, New York. Mr. Stein is an architect in private practice whose firm has become known for their architectural work, their planning studies, and their pioneering work in the energy field. His concern for building performance, satisfaction of clients' programmatic needs and economy both in construction and in operation has led to a deep interest in the relationship between buildings and energy use. Mr. Stein has been the recipient of many government and privately funded research grants to study energy use by the entire building industry. He is the author of the book Architecture and Energy, as well as numerous other articles and interviews in Science magazine, Newsweek, the AIA Journal, the Architectural Forum, Architectural Digest and others. His firm has received design awards and citations for schools, treatment centers, parks and recreation facilities. Mr. Stein is an adjunct professor at Cooper Union School of Architecture, a fellow of the American Institute of Architects and past president of the New York Chapter of the AIA, and served for two years as the Chairman of the New York State Board for Architecture. He holds a B.Arch from New York University, and a Masters degree from Harvard University.

JOHN ZEISEL, principal, Zeisel Research, Cambridge, Massachusetts. Dr. Zeisel is a sociologist focusing on communicating research information to designers and meeting special user needs. His areas of specialization include programming and evaluation of building projects, sociological research in design decision making, and making information useful in innovative design. His experience covers a broad range of building types, including offices, housing, hospitals and schools. Dr. Zeisel was a Loeb Fellow in Advanced Environmental Studies at Harvard University, and taught in the architecture department there as well as at Yale and McGill Universities. He is a member of the Environmental Design Research Association, the American Sociological Association, the American Institute of Architects Urban Design Committee, the American Association of Housing Educators, and serves on the Editorial Boards of Environment and Behavior and Housing and Society. He is the author of numerous articles and reports including Inquiry by Design: Tools for Environment-Behavior Research, a text used in architecture, sociology and psychology courses at colleges and universities throughout the United States and Canada. Dr. Zeisel holds a B.A. in chinese studies and a PhD in Sociology from Columbia University.

APPENDIX C: PARTICIPANTS IN ABBE WORKSHOP ON ENERGY CONSERVATION IN BUILDINGS AND COMMUNITY SYSTEMS February 9 - 11, 1982

COMMITTEE CHAIRMAN: Richard C. Jordan, Professor and Associate Dean, Institute of Technology, University of Minnesota

PANELS

1. Chairman: Jerold W. Jones, Associate Professor of Mechanical Engineering, Coordinator of Conservation Studies, Univer- University of Texas

   Members

   Ralph F. Goldman, Director, Military Ergonomics Division, USARIEM Natick, MA

   Richard Rittelman, Burt, Hill, Kosar and Rittelman, Butler, PA

   Fount T. Smothers, AIA, Professor, School of Hotel Administration, Cornell University, Ithaca, NY

   William Such, Vice President, Engineering, Tennessee Gas Pipeline Co., Houston, TX

2. Chairman: Preston McNall, Chief Building Physics Division, Center for Building Technology, National Bureau of Standards, Washington, DC

   Members

   Henry Kelly, Senior Associate, International Security & Commerce, Office of Technology & Assessment, Washington, DC

   Robert O. McDonald, Manager, Customer Relations, Commercial Division, Honeywell, Inc., Arlington Heights, IL

   John Spengler, Professor, School of Public Health, Harvard University Boston, MA

   Jan Stolwijk, John B. Pierce Foundation, New Haven, CT

   James E. Woods, Jr., Department of Architectural and Mechanical Engineering, Iowa State University, Ames, IA

3. Chairmen: Gershon Meckler, Partner and Director of Engineering Design, Haines Lundberg Waehler, New York, NY
Erv Bales, Haines Lundberg Waehler, New York, NY

Members
Calvin Hamilton, Director of Planning, Department of City Planning, City Hall, Los Angeles, CA
Walter Kroner, Associate Professor & Director, Center for Architectural Research, Rensselaer Polytechnical Institute, Troy, NY
Noam Lior, Professor, Mechanical Engineering, University of Pennsylvania, Philadelphia, PA
David McFayden, President, Technology & Economics, Inc, Cambridge, MA
John Weidt, John Weidt Associates, Chaska, MN

4. Chairman: Richard Stein, FAIA, The Stein Partnership, New York, NY

Members
Bruce Anderson, President, Total Environmental Action, Inc., Harrisville, NH
Charles Copeland, Partner, Goldman, Sakalow, Copeland, New York, NY
James Marsten Fitch, Director, Beyer, Blinder, Belle, New York, NY
Richard Schoen, Associate Professor of Architecture, Graduate School of Architecture, & Urban Planning, University of California, Los Angeles, CA

5. Chairman: Foster C. Wilson, Research Director, Regulatory Technology, Fiberglas Technical Center, Owens-Corning Fiberglas, Granville, OH

Members
Jack M. Cherne, PE, Program Manager, Alternate Energy Systems Applications, Energy Systems Group of TRW Inc., Redondo Beach, CA
Robert Loftness, Director-Washington Office, Electric Power Research Institute, Washington, DC
Ralph J. Johnson, President, NAHB Research Foundation, Inc., Rockville, MD
Emanuel Levy, Senior Associate, Steven Winter Associates Inc., New York, NY
Andrew Schon, Xenergy Inc., Burlington, MA

6. Chairman: John Zeisel, Ph.D., Zeisel Research, Cambridge, MA

Members
Camilla Auger, Vice President, TOSCO, Boulder, CO
Sital Daryanani, Syska and Hennessy, Inc., New York, NY
Gary Hack, Department of City & Regional Planning, Massachusetts Institute of Technology, Cambridge, MA
Peter Mill, Director, Directorate of Architectural Science, CANADA
Edwin Woll, Associate, Frank O. Gehry & Associates, Venice, CA

CONSULTANTS

American Consulting Engineers Council, Washington DC
Thomas V. Tiedeman, Director
Edward J. Liese, Program Manager
Colorado Energy Research Institute, Lakewood, Colorado
Martin D. Robbins, Director
Natalie Langue, Consultant, ABBE, Washington, DC
Thomas Vonier Associates, Inc., Washington, DC
Thomas Vonier, President
Peter Smeallie, Vice President

ABBE STAFF

John P. Eberhard, Executive Director, ABBE, Washington DC
Joan D. Finch, Program Manager
Delorse M. Thompson, Secretary

SPONSORS

John Cable, Director, Building Systems Division, Department of Energy, Washington, DC
Maxine Savitz, Deputy Assistant Secretary for Conservation, Office of Conservation and Solar Energy, Department of Energy, Washington, DC

GUESTS

Mary Ann Eichenberger, The American Institute of Architects, Washington, DC
James Frazier, Board on Toxicology & Environmental Health Hazards, National Academy of Sciences, Washington, DC
Jerome Rothenburg, Program Manager, Building Technology Division, Department of Housing and Urban Development, Washington, DC

Mr. FUQUA. Very well put. Thank you.
Mr. Morgenroth.

STATEMENT OF DAN MORGENROTH, OWENS-CORNING FIBERGLAS, TOLEDO, OHIO

Mr. MORGENROTH. Thank you, Mr. Chairman.

I am Dan Morgenroth, and I am appearing today as an individual who has been involved in implementing technology in buildings for more than 35 years, most of which has been in the private sector. Although my name is listed as from Owens-Corning, that just happens to be a convenient mailing address, as I retired about a year ago.

Mr. FUQUA. I see.

Mr. MORGENROTH. I have already provided detailed written statements for the subcommittee, which have been directed toward specific technical points, and I would like to have that document as a matter of record, Mr. Chairman.

Mr. FUQUA. Yes. We will make all three statements a part of the record, without objection. Without objection, your statement will be included in the record.

Mr. MORGENROTH. I would like to summarize some of the highlights of my written statement for you today. I will first try to help the subcommittee evaluate the building energy research program transmitted to this subcommittee under date of April 14, 1982, by David O. Meeker, FAIA, and to answer the question, which is the

most cost-effective use of public funds for a building energy research program.

The building energy research program assumes a need for a strong Federal role in supporting and sponsoring a wide range of building energy research projects. I believe this assumption is invalid. The Government should indeed be involved but in selected types of projects, as I will detail.

The Government should not compete with the private sector, which has made and will continue to make extraordinary progress toward understanding many of the problems listed in the subject document. In general, there is no need for a Federal welfare fund for building energy research.

Briefly, I will discuss some of the problems with the building energy research program that was submitted previously.

First, a good share of the projects listed would simply confirm that which we already know and could not be called research at all. The industry in many cases has the knowledge of more energy-efficient building practices, yet the various aspects of the economic picture are not favorable enough to adopt them yet.

Second, many of the projects listed should be conducted and funded by the private sector. Development of products such as more efficient building materials, system controls, high-efficiency appliances, and better heating and cooling systems have been and will continue to be undertaken by the manufacturers that stand to gain by them.

In addition, some superior products are already available. But our building science outpaces our building practice due to a combination of economics, aesthetic values, local skills, local materials, social habits, and other factors.

Third, the document does not prioritize research needs. The emphasis should be where the biggest paybacks will result. Energy technology for new buildings is further advanced and yet has far less effect on our national energy picture than that for the far larger stock of existing buildings.

Fourth, no rationale is given to justify either continuation of present projects or beginning recommended ones. There appears to be no acknowledgement of existing research programs.

If not the building energy research program, what then should the Federal Government be funding?

Based on my broad and diversified experience in building technology, I believe the "National Program Plan for the Thermal Performance of Building Envelope Systems and Materials" sponsored by DOE to be a superior plan and worthy of the subcommittee's attention. That was presented by Mr. Cable earlier.

In August 1975 the American Society of Heating, Refrigeration, and Air-Conditioning Engineers published "ASHRAE Standard 90-75." This standard was used as the basis for the development of the model energy code by NCSBCS for use by the various States.

Public Law 94-163 of December 22, 1975, the Energy Policy and Conservation Act, among other things included mandatory thermal efficiency standards and insulation requirements for new and renovated buildings. Public Law 95-619 of November 1978, the National Energy Policy Conservation Act, provided for regulations to

reduce the growth in energy demand in many sectors of our economy, including buildings.

Therefore, the building community needed technical information in support of this legislation as well as the new State energy codes. To provide this support, the Office of Conservation and Solar Applications, the Department of Energy, and the National Bureau of Standards, Department of Commerce, with comments from representatives of the manufacturing, design, and associated organizations, developed the "National Program Plan for the Thermal Performance of Building Envelope Systems and Materials" published in 1979.

This original plan has now been revised and updated as a cooperative effort among all sectors of the building industry, academia, and Government organizations. This document was issued March 1982 as ORNL/Sub-7973/1. This document is the result of 6 years of diligent efforts by hundreds of people from all sectors of the building community. It provides a guiding light for an energy research agenda.

While the plan carries a detailed agenda of research and development needs, it provides for the cooperation between the public and private sectors and opportunities for the entrepreneur as well as the laboratory scientist.

The scope of the national program plan includes not only energy transfer within and through building envelopes and envelope-related subjects but also the various interfaces between envelopes, mechanical and electrical systems, and technology transfer to be put to use in the building process.

Because of the diverse interests in the building community, there is a strong recommendation to establish a coordinating council that would represent a very heterogeneous mix of people from both the public and private sectors. This group would help reduce constraints, allow for better cooperation, better dissemination of information, offer planning and training courses, form an information resource center, and many other activities.

The coordinating council would be a well-balanced body of individuals who shall be decisionmakers in their respective areas of expertise, of recognized stature in the building community, and representatives of those having a major interest in and the ability and willingness to contribute to the development and execution of the NPP.

I recommend that funding be provided to support the secretariat of this body which will supply administrative services to handle the day-to-day tasks of administering the work of the council. I further suggest that the coordinating council and its secretariat be housed at the National Institute of Building Sciences.

The specific charge by the Congress of the United States to the Institute is to be an "authoritative national source to make findings and to advise both the public and private sectors of this country with respect to the use of building science."

Why the emphasis on building envelope systems? The building envelope is the exterior shell of the building consisting of glass, structure, insulation, masonry, marble, wood, et cetera, and is the barrier between the interior environment and exterior weather. The envelope is that part of a building with the longest useful life

and therefore has the greatest long-term impact on building energy efficiency.

The other five fundamental systems of a building related to energy use are the HVAC equipment, HVAC systems lighting, electric distribution, and service water heating. All these systems have a relatively short life compared to the envelope system and are replaced as age, operating costs, and economics dictate.

Creating the thermal envelope is a complex task involving numerous actors. Architects, engineers, research laboratories, testing organizations, manufacturers of a whole host of materials, trade associations, professional societies, consumers, Government agencies, and many labor crafts all have an impact on the building envelope system. Their competing and conflicting interests create a diversity of choices. Currently there is no major overriding interest such as an industry or trade association which encourages them to work together for better energy conservation. The Government, through the national program plan, should help coordinate these separate efforts into a unified endeavor.

Mr. Chairman, I have listed a number of recommendations for cooperative research in my written document which I have submitted, and I would just like to make about four points.

First of all, I would recommend the sponsoring of the secretariat and the coordinating council for the implementation of the national program plan for cooperative research between the public and private sectors of the building community and to support the research agenda as a superior research plan.

No. 2, I would recommend the establishment of methods of collecting historical weather data for the design of energy-efficient buildings on a ZIP code basis on microclimates throughout the United States. The weather stations at the airports and other designated locations collect data primarily for weather forecasting. Historical weather data is of extreme importance to all elements of the construction industry from the designers, to the installers, to the code officials. In some areas of the country the local utility companies record weather data for their own use, but this data is inadequate for many of the computer programs that are used in predetermining energy use.

With the increase in energy costs and the use of ASHRAE Standard 90 as the basis of an energy code in 48 States, the use of weather data has taken on a renewed importance, and it is no longer adequate to use the historical weather data recorded at airports where very few buildings are erected.

While NOAA is doing an outstanding job in forecasting for the aircraft, marine, and agricultural industries, the building community needs different kinds of data to implement the building energy codes and support of the legislation that has been mandated by Congress.

First of all, the mesoclimate data, which is regional climate data, is developed by NOAA with sophisticated equipment, the use of satellites, and that is all very useful and is excellent. However, we need microclimate data, and urban and suburban weather data is needed so that the industry can use their DOE–II computer programs and other programs in determining and predicting the energy utilization within buildings.

It is suggested that this information can be recorded not by expanding NOAA but by using technicians, professionals, and qualified students at selected schools and universities on a ZIP code basis. With some solid state new equipment, the need for recalibration is minimized.

No. 3, I would like to recommend—we heard a lot about the solar and those various solar programs. I am very familiar with most of the work that is going on in the national laboratories, but the one thing that is not going on at the present time is the development of a research and a standard fenestration testing tool. I would like to recommend that a Fenestration Laboratory be provided to update all technical data on composite window constructions.

There is a need to research and standardize and update material on technical information on solar heat gain and thermal loss through composite window constructions, not just through the glass but through total construction.

The impact of utilization of natural lighting—which is one of the problems that Gardner brought up—infiltration and the use of windows for ventilation and so forth, and use it as a basis for developing useful design tools for the building industry to use. Right now we do not have design tools, and testing more buildings is not going to get us more basic design tools.

This project will probably not be funded by the private sector. The reason is that there are technical problems. There are also legal problems. There are also some business reasons of interrelationship with various people in the industry.

Today's buildings are using basic design data on window heat transfer from the ASHRAE solar calorimeter that was constructed over 35 years ago and was used throughout the 1950's. When ASHRAE closed its Cleveland research facility, this equipment was transferred to the University of Florida. With the intervening drastic changes in technology of windows, this basic facility can no longer adequately handle the requirements for studying the performance of composite window constructions and managed wall systems as they are becoming very complex in their solar and thermal performance.

No. 4, I recommend the establishment of a national information resource center at the National Building Museum. There have been several questions about information retrieval, and I have a point of view on that. In the United States, we have excellent information retrieval in medical circles, in the chemical industry, and in the Erich system in education, but there is no such system or capability for construction technology. Quantities of early research documents even from our own National Bureau of Standards are either out of print or unobtainable, and some of the reports are only 25 years old.

I recommend that a building information technology resource center be established at the National Building Museum housed in the historic Pension Building. This is a nonprofit organization established by Congress only a few years ago.

In the original legislation, this National Building Museum was set up as a resource information center for the building community, but funding has not been granted for this purpose. This center would collect reports, publications, and all printed information re-

lated to building technology, first from all U.S. sources, then from other nations such as Canada, Scandinavian countries, and other people who have also tackled the energy problem.

This information resource center would catalog all information and provide a cross reference and abstract service that could supply the information in many forms and formats. But this is a resource for such organizations as the AIA, NAHB, the National Institute of Building Sciences, and so forth, to collect this data and make it useful to the profession. Right now a lot of past research is being lost.

No. 5, I would like to recommend support of the calibrated hotbox at the National Bureau of Standards for developing standards and performance values for use by building designers and building code officials.

The Department of Energy and the National Bureau of Standards, in cooperation with many sectors of the building community, have built a large, full-scale calibrated hotbox to measure the heat transmission through composite building construction. While other similar equipment has been put into operation by private interests, America needs a reference standard for the development of a reliable information base for the implementation of State energy building codes.

It is imperative that the Bureau of Standards provide the leadership for the building community and that basic thermal performance data on standard popular composite constructions be developed and published for use by the design profession and code officials. This, again, is a project that will not and probably cannot be performed by the private sector for technical, legal, and business reasons.

I have several other just brief comments. No. 1: There was some discussion relative to indoor air quality. I would like to draw the this committee's attention to the report, which is an interagency report, on "Indoor Air Quality from Leesburg, Virginia, 1981," and the National Assembly of Life Sciences Report on the "Committee on Indoor Pollutants, 1981." Both of those have a research agenda—a recommended agenda—for Government support, and I am not certain that it is appropriate that this be within the Department of Energy. This program deals mostly with health problems—medical problems.

I would like to recommend that Congress establish a methodology for coordination of the research programs within the public sector. Not only do we have the Department of Energy; we have the Department of Commerce and the Department of Agriculture. The Department of Defense has over 42 million dollars' worth of research in building-related research because of their shore facilities.

I recommend an orderly phaseout of technology development and tests of demonstration installations in active solar programs and that no new passive solar verification programs should be initiated. My written testimony gives a list of many of the projects which are underway and which I recommend be continued, and that no new ones started.

I also recommend documentation of research and the results of past and existing systems projects should be assimilated and dis-

seminated to the industry. I also recommend that DOE should support some high-risk, long-range solar research with high potential benefit that cannot be done by the industry in the solar field. These are in my written testimony.

Thank you very much for this opportunity to present my views relative to the building energy research program, Mr. Chairman.

[The prepared statement of Mr. Morgenroth follows:]

Committee on Science & Technology
U.S. House of Representatives,
Rayburn House Office Building.

Testimony for the
Energy Development and Application Subcommittee
on
Building Energy Research

by
Dan E. Morgenroth, P.E.

July 22, 1982

DAN E. MORGENROTH

Professional Responsibilities

- Professional Engineer
- Director, Market Development, Owens-Corning Fiberglas Corporation

  Market Development organization is responsible for strengthening and directing technical marketing programs to meet the new business goals and objectives of the various Operating Divisions and the Corporation. This is accomplished by continually assessing the impact of external technological forces on present business activities and as a resource sounding board to choose of the best technical alternatives for growth.

- Project Manager of the Design Team on the GSA Building by Systems Program for procurring SSA office buildings in Philadelphia, Chicago, Richmond, Baltimore and Woodlawn. One of the major key elements of the bidding was 40 year life cycle costing for energy. The team consisted of a consortium of Owens-Corning, U.S. Steel, Westinghouse Corp. and Wolff & Munier.

Professional Activity

American Society for Testing and Materials Committee C-16 and E-06 since 1952, Chairman C16.23 1967-1968.

Building Research Institute since 1951, Vice President, 1968-1970.

Building Research Advisory Board - NRC-NAS 1975-1981, Vice Chairman 1978-1980.

American Society of Heating Refrigerating & Air Conditioning Engineers, Member since 1965

- Research & Technical Committee, 1980-1983
- Research Activities Subcommittee 1981-1983
- Section Head for Technical Committees for Load & Energy Calculations 1980-1983
- ASHRAE Standard 90 Committee Since 1974

Co-chairman of ASHRAE/DOE Conference - Building Thermal Envelope System II, Dec. 1982

Leader U.S.A. delegation to Soviet Union — U.S./U.S.S.R. Joint Committee on Cooperation in Housing and Other Construction - 1.4 and 1.5 - Building Materials and Components

BUILDING ENERGY RESEARCH PROGRAM
EXECUTIVE SUMMARY OF RESEARCH RECOMMENDATIONS

by Dan E. Morgenroth

- Recommend sponsoring the Secretariat and the "Coordinating Council" for the implementation of the National Program (NPP) for cooperative research between the public and Private sectors of the building community and support the research agenda as a superior research plan.

- Recommend Congress should establish a methodology for coordination of research programs within the public sector agencies. The NPP "Coordinating Council" could perform necessary communication and other functions.

- Recommend the establishment of methods of collecting historical weather data for the design of energy efficient buildings on a ZIP code basis for micro-climates.

- Recommend support of the Calibrated Hot Box at the National Bureau of Standards to develop standards and performance values for use by building designers and building code officials.

- Recommend the establishment of a Fenestration Laboratory to provide updated technical data on composite window constructions.

- Recommend the establishment of a National Information Resource Center at the National Building Museum.

- Recommend that the government support research on indoor air quality recommended in the "Interagency Report on Indoor Air Quality" - Leesburg, VA, 1981 and the NAS-ALS report by the "Committee on Indoor Pollutants", 1981.

- Recommend an orderly phase-out of technology development, and tests of demonstration installations in the active solar programs and no new passive solar verification programs should be initiated.

- Recommend that documentation of research and technical results of past and existing systems should be assimilated and disseminated to the industry.

- Recommend that DOE should support high risk, long range research with high potential benefit that has not been attempted by the industry in the solar field.

NATIONAL PROGRAM PLAN FOR THE THERMAL PERFORMANCE OF BUILDING ENVELOPE SYSTEMS & MATERIALS

In August 1975, the American Society of Heating, Refrigeration & Air Conditioning Engineers published ASHRAE Standard 90-75. This standard was used as the basis for the development of the Model Energy Code by NCSBCS for use by the various states. Public Law 94-163 December 22, 1975 "Energy Policy and Conservation Act" Title 5, Part C provides for Federal support for review and approval of State energy conservation plans which includes mandatory thermal efficiency standards and insulation requirements for new and renovated buildings.

Public Law 95-619 November 1978, "National Energy Policy Conservation Act" provided for regulations of interstate commerce to reduce the growth in energy demand in the U.S. and to conserve non-renewable energy resources, without inhibiting beneficial economic growth.

The building community needed technical information in support of this legislation and the new state energy codes. To provide this support, the Office of Conservation and Solar Applications, The Department of Energy and The National Bureau of Standards, Department of Commerce, with comments from representatives of the manufacturing, design, and associated organizations, developed a "National Program Plan for the Thermal Performance of Building Envelope Systems and Materials."

This original plan has now been revised and updated as a cooperative effort between the building industry, academia and government organizations. This document was issued March 1982 as ORNL/Sub-7973/1.

The objectives of the NPP are:

1) Describe the research and development, and verification efforts and provide a sound technical and economic foundation for the design, conservation, operation, and modification of new and existing buildings for optimum energy efficiency, while preserving other performance requirements, such as habitability, safety, health, costs, durability, etc.

2) Describe and promote the activites needed in the various sectors of the building community, to expedite the use of new technologies and building practices.

The current draft was developed by truly knowledgeable industry and educational leaders working with government representatives, including 24 representatives from industry, 7 from academia and 7 from government agencies.

Despite the imperfections in the implementation process for new technology for energy conservation in buildings, considerable progress has been made during the past four years through various cooperative efforts of the public and private sector.

This publication lists 14 major areas of accomplishments by the building community and at least 19 areas of research, development and implementation tasks, yet to be completed to achieve the National Program Plan objectives.

While the plan carries a detailed agenda of research and development needs, it provides for the cooperation between the public and private sectors and opportunities for the "entrepreneur" as well as the "laboratory scientist."

11-221 O—82——13

The scope of the NPP includes not only energy transfer within and through building envelopes and envelope-related subjects, but also the various interfaces between envelopes, mechanical and electrical systems and technology transfer to be put to use in the building process.

Because of the diverse interests in the building community, there is a strong recommendation to establish a "Coordinating Council" that would represent a very heterogeneous mix of people from both the public and private sectors. This group would help reduce constraints, allow for better cooperation, better dissemination of information, offer planning, and training courses, form an Information Resource Center and many other activities, as outlined in the NPP.

The "Coordinating Council" would be a well balanced body of individuals who shall be decision-makers in their respective areas of expertise, of recognized stature in the building community and representatives of those having a major interest in and the ability and willingness to contribute to the development and execution of the NPP.

I recommend that funding be provided to support the Secretariat of this body which will supply administrative services to handle the day-to-day tasks of administering the work of the council. All the necessary groundwork for the establishment of a functioning "Coordinating Council" should be completed by the beginning of FY'83. Such an activity "will permit more efficient use of very limited federal funds" that, when combined with private funds, can accelerate the implementation of the National Program Plan for the Thermal Performance of Building Envelope System and Materials.

I further suggest that the "Coordinating Council" and its Secretariat be housed at the National Institute of Building Sciences.

The specific charge by the Congress of the United States to the Institute is to be an "authoritative national source to make findings and to advise both the public and private sectors of the economy with respect to the use of building science and technology in achieving nationally acceptable standards and other technical provisions for use in Federal, State, and local housing and building regulations; also, to exercise its functions and responsibilities in, among others, the areas of needed technical investigations and the assembly, storage, and dissemination of technical data and other information. Further, the Congress authorized federal departments and agencies to contract with the Institute and encouraged their acceptance, use and compliance with technical findings of the Institute.

WHY THE EMPHASIS ON BUIDING ENVELOPE SYSTEMS?

Of the six fundamental systems related to energy utilization in buildings (lighting, HVAC equipment, envelope, HVAC Systems, Energy Distribution Systems and Service Water heating), all <u>except</u> the envelope (BTESIM) utilize specialized professional services of engineers and involve a limited number of manufacturers and labor trades. For example, designing and implementing a lighting system is a relatively straightforward process involving lighting designers, engineers, manufacturers and electricians who together provide for the proper quantity and quality of light. In comparison, creating the thermal envelope is a complex task involving numerous actors. Architects, engineers, research laboratories, testing organizations, manufacturers of a whole host of materials, trade associations, professional societies, consumers, goverrnment agencies, and many labor unions all

have an impact on the building envelope system. Their competing and conflicting interests create a diversity of choices. Currently, there is no major overriding interest, such as an industry or trade association, which encourages them to work together for better energy conserving buildings. The government, through the National Program Plan, should help coordinate their separate efforts into a unified endeavor.

COMPLEMENTARY RESEARCH AGENDAS

The American Society of Heating, Refrigeration, and Air Conditioning Engineers (ASHRAE) has been sponsoring its own research and development activities for over eight years. This Professional Society sponsored its own research laboratory which ceased operation in 1959. Subsequently, the society carried its own research and development commercial laboratories at colleges and universities. The current annual budget for ASHRAE Research & Development is $750,000 of private funds.

Because much of this research involves multi-year projects, ASHRAE currently has over one million dollars committed annually to research supported by the private sector of the building industry.

To give some idea of the amount of research planning underway in the private sector, I have a copy of a listing of almost 350 research projects developed by the 91 Technical Committees and Task Groups. This is a "grass roots" effort by society to utilize expertise from all sectors of the building community. These projects are continually updated to take advantage of new technology and the need to speed up its implementation in the building process.

This research agenda represents projects of various magnitudes, many of which are large enough to require cooperative support of both the public and private sector. Many of these proposed projects are integrated with and complement the NPP.

It may be of interest to note that many government professional employees are members of ASHRAE. This improves communication in all sectors relating to energy efficiency projects.

CRITIQUE OF THE BUILDING ENERGY RESEARCH PLAN

Introduction

This plan assumes the need for a strong federal role in the sponsorship and guiding research on energy utilitzation in buildings. Nowhere in this document is there a program to create incentives for the designers, owners, users, contractors or others to use the output from such a plan.

It has been my good fortune to be involved in efficient energy utilization in buildings for over 35 years. I have intimate knowledge of the mountains of technical data and useful design information which has been created in the past 30 years. That experience began with the Small Homes Council at the University of Illinois in partial support of the FHA's original Minimum Property Standards in 1949 and continued through the present ASHRAE Standard 90 Project Committee. I have also prepared three chapters for the ASHRAE "Handbook of Fundamentals" in the 60's and 70's, among other writings.

Mr. Chairman, it is important to note between 1950 and the beginning of the energy crisis in 1973, we in America have had the technical and production knowledge to double the amount of occupied space for residences, commercial and institutional buildings and that these buildings in the main provide an acceptably built environment.

The design of buildings has been, and still is to a large extent, based on building practice as contrasted with what may be called building science. Changes come slow and in the main come about through an evolutionary process of trail and error. The evolutionary process works slowly under the influence of new factors, and is equally slow in rejecting the obsolete.

The growth of scientific knowledge has led to great advances in the analysis and rational design of energy efficient buildings. The increased price of energy has caused the development of new energy efficient materials, building components, and building systems. This increased cost of energy, coupled with government legislation requiring State Building Codes for efficient energy utilization, has caused a demand for more knowledge in this design discipline.

The great cooperative efforts between the public and private sectors developed in the past 30 years developed much more technology than is being effectively utilized in buildings today. The past eight years have brought a literal explosion of new technology as well as confirmation of past knowledge relative to effective energy utilization. There have been relatively small advances in assimilation of these great quantities of new information.

Those who are responsible for assessing and screening these new developments also have the difficult task of zeroing in on specific research needs that will further refine energy conscientious design.

The government's primary goal should be to assimilate and disseminate this knowledge and to provide the incentives for its use. The public sector should serve as the catalyst that prompts the private sector to support most of the research activity. The government itself need not support new product development.

But let me assure you that the government isn't the only entity currently experiencing the impact of limited financial resources. The appliance and equipment industries, the building system manufacturers, and the building materials producers, among others, are now beginning to apply their latest technologies to produce products, materials and systems that will have a competitive edge at a cost-effective price. Their incentive to provide more cost effective energy efficient products is for the survival of the companies.

The Building Energy Reserach Program assumes that a strong federal sponsorship of research and development is required. I believe this assumption has been shown invalid by the National Program Plan for the Thermal Efficiency of the Building Envelope sponsored by DOE. I submit that the National Program Plan provides a better research agenda for your committee. Why?

1) Its authors include a coalition of 7 government bodies, 7 academic institutions, and 24 industry members. This broad base support leads to greater information transfer and more efficient use of both public and private research funds facilities and manpower.

2) It also identifies the private sector's research role in improving building energy technology.

3) Finally, it identifies and prioritizes the subjects that have not received adequate research attention and does not reinvent the wheel. As our standards of performance are continually being raised and we solve our major difficulties, minor ones assume greater relative proportions. We clamor for their reduction or elimination in the name of progress. The National Program Phase identifies the relative importance of needed research.

I recommend sponsorship by the federal government of the administrative activities needed for support to the National Program Plan because it provides the appropriate mechanism for cooperation between the public and private sectors. In addition, the government also has a role in a number of specific technologies that will be outlined elsewhere in the report.

COMMENTS ON INTRODUCTORY ITEMS IN THE BUILDING ENERGY RESEARCH PROGRAM

Relative to the proposed reorganization of DOE, the Department of Energy currently has the "Office of Conservation and Solar Applications." While there may be some duplication of research efforts at the lower levels of the Conservation Section and the Solar Section, I believe management should resolve that and no reorganization of DOE is needed. On projects where competition may be a factor, the appointment of a lead agency by the Assistant Secretary can minimize duplication. In the real world of research grants on major projects, there are many examples of coordination at the contractor level. I This proposed plan is neither "integrated" nor "comprehensive," as it claims. No-where does this document recognize the ongoing private sector support and initiatives underway to achieve the same goals. I can only comment that the sponsors of the proposed plan are out of touch with the current realities of energy efficient design and practice. Let me comment upon what the document calls the "key aspects of the proposal."

Page 2, Point 1 — It is true that "Buildings should be treated as integrated and dynamic energy-using systems"; however, it is the professional designers' responsibility to interface the components and systems and should not be the basis of a Building Energy Research Program.

Page 2, Point 2 —Measuring "The actual behavior of energy usage in occupied buildings is a dream of the uninitiated." This type of program has been attempted off and on for 30 years of my own experience. Most recently, it has been pursued on such buildings as the GSA Manchester Office Building (published 1980), the Newark Public Service Building (in progress), the Jersey City Total Energy Plant and District Heating System (report at the government printing office 1982) Twin Rivers Project, New Jersey (report issued), and 23 commercial buildings of the Passive Solar Commercial Building Program which is really an Energy Conscience Design Program (in progress). In addition, about 4000 residential and over 200 commercial active solar heating and cooling systems were installed on a demonstration basis under the provision of the Solar Heating and Cooling Demonstration Act of 1974. Several years later, 19 building experiments were funded to demonstrate passive and hybrid solar heating and cooling systems - DOE/CS4970-1 November 1980.

There are many problems encountered in researching occupied buildings:

- The occupants distort the results because of variables such as usage, habits, incentives, etc.
- It is assumed that the best technology has been used in designing the building system. This is generally false as the design team usually has certain biases and limited knowledge.
- The systems installed do not perform in an efficient and effective manner and require debugging before any data can be taken that would prove meaningful. The inter-relationship of the various building systems is generally very questionable.
- Any demonstration program must be kept simple because a complex system would create complications and require expert planning to prevent interface problems. This simplicity also introduces biases.
- Such projects need to be inspected in detail during the construction process so that the later data might prove even marginally useful.
- The crafts need special training to assure proper technicques have been applied.
- Extra effort in inspection is required where systems and crafts interface.
- Equipment for measuring the performance of the various data collecting points need to be installed by specialists. Many have been installed by the wrong craft and have not functioned properly.

It is recommended that no new verification programs be authorized until the present technical data can be analyzed.

Page 2 and 3, Points 3, 4, 5 — The National Program Plan address these points well.

Page 3, Point 6 -- Two subjects must be addressed under health and safety issues: effects of indoor pollutants on people and methods of controlling them. The methods for measuring infiltration and controlling pollutants with ventilation systems is well known. The effect of pollutants on people, when relating to indoor air quality, has been considered at The National Academy of Science — Assembly of Life Sciences in its report entitled "Committee on Indoor Pollutants" and the "Interagency Report on Indoor Air Quality at Leesburg, Virginia, 1981." These two reports contain specific recommendations for government support at such government agencies as The National Institute of Health, Environmental Protection Agency and O.S.H.A.

WEATHER DATA

The Weather Stations at the airports and other designated locations collect data primarily for weather forecasting. Historical weather data is of extreme importance to all elements of the construction industry from the designers to the installers to code officials. In some areas of the country, the local utility companies record weather data for their own use, but this data is inadequate for many of the computer programs on energy use.

With the increase in energy costs and the use of ASHRAE Standard 90 as the basis of an energy code in 48 states, the use of weather data has taken on a renewed importance. It is no longer adequate to use the historical weather data recorded at airports where very few buildings are erected. While NOAA is doing an outstanding job in forecasting for the aircraft, marine, and agriculture industries, the building community needs different kinds of data to implement the building energy codes and to take advantage of new technology, systems and materials that are coming to the market place.

Misoclimate - Regional climate information developed by the present NOAA organization with sophistocated equipment and satellites is very useful, particularly in the rural regions.

Micro-climate - Detailed urban and suburban weather data is needed. It is suggested that this information can be recorded by technicians or professionals and qualified students at selected schools and universities on a ZIP code basis. With new solid state equipment, the need for repeated calibration is minimized.

What kinds of data should be recorded on a ZIP code basis for micro-climate information?

- Dry bulb and wet bulb temperatures on an hourly basis;
- Wind direction and speed, hourly:
- Solar irradiation, both direct and diffuse, hourly:
- Illumination in 5 planes — North, East, South, West and Vertical, hourly:
- Ground temperatures, daily basis.

The following article by Francis de Winter from Solar Age Magazine outlines many of the problems using present solar data without mentioning the heat problems in the inner cities in summer and the humidity problems relating to cooling costs.

COMMENTARY

Solar Radiation Measurement: a National Disgrace

By Francis de Winter

Serious federal funding of solar energy research, development, demonstration, and commercialization has been going on for nearly 10 years. As with any technology, one might argue that parts of the work have been underfunded while significant amounts of money have been spent on "demonstrating" half-baked technology and other frivolous tasks. In most areas, however, good work has been done.

But one area of solar R&D should be clearly recognized as an unmitigated national disaster and disgrace: the measurement and characterization of the insolation resource.

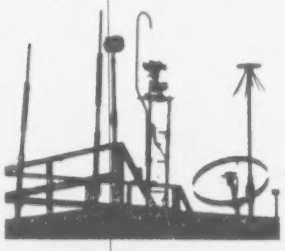
In the early 1970's, there were about 60 reasonably well-equipped stations measuring solar radiation in the United States. They were generally located at airports or weather stations; the value of any location from a solar energy point of view was coincidental. The data were only of academic interest, contained many gaps, and were of questionable accuracy.

Climate is often a highly local phenomenon. Close to oceans, lakes, or mountains there can be astounding climate changes within even five miles. To have 60 stations in the United States is simply ridiculous. One probably needs 1,000 to 2,000 stations even to begin to understand the resource. The inadequacy of the present data is quite clear. When an insolation map of the United States shows five "equal insolation contour lines" passing between the two *closest* stations at one point, one has poetic license, not scientific fact. Many such areas of ignorance exist in urban centers, where knowledge is most critical.

If solar energy is to fulfill a reasonable percentage of our needs in the future, insolation levels must be accurately known.

Knowing insolation levels does more than simply reduce the cost of trial and error in solar design. Trial-and-error agriculture is a very expensive proposition. In building dams, misjudging water evaporation by a foot or two a year can skew power production estimates by thousands of dollars per year. Careful insolation measurement is an incredibly cost-effective investment.

The growth of the federal solar energy



budget over the past 10 years should have led to a vast increase in the number of insolation measurement stations, in the accuracy and thoroughness of the measurements, in the development of equipment, and in the effort spent interpreting and packaging the data. It did nothing of the sort. There are fewer stations (38) now than a decade ago, and the results are as unreliable as ever.

Early in the 1970's it was found that the black coating on many pyranometers had turned green, resulting in drifts in calibration as great as 20 percent. Ignorance of the rate of drift made all previous data questionable. This discovery led to data rehabilitation based on the assumption that maximum insolation levels at solar noon on clear days had not changed over the years. One might have hoped that it would also lead to reasonable care of the instruments. It did not.

An inspection of California stations several years ago yielded the following results:

- At Riverside (one of the oldest and most trusted insolation stations in California) the top of a vent pipe regularly cast a shadow on one of the instruments.
- At Fresno State University trees covered enough of the skydome to make diffuse radiation measurements questionable.
- At Los Angeles airport (and at Fresno) an aluminum dome was close enough to the instruments so that reflected energy made the readings questionable.
- At another installation a perch above the instruments was a favorite spot for birds, and only rains seemed to be used to clean bird droppings off the unit.

Most meteorological instruments are pretty foolproof and do not need frequent attention. Careful insolation measurements require frequent checks of the instruments to clean them, to replace or regenerate the desiccant packages that keep them dry, and to determine first-hand if anything is shading the instruments, or if shading rings are positioned accurately for devices that measure diffuse radiation. The instruments instead suffer almost complete neglect.

Instrument use in demonstration projects is similar. There is probably a 10 to 1 chance that a given instrument will be found dirty, with the desiccant capsule pink (i.e., waterlogged). Whether the measurements obtained with these instruments are worth anything only God knows.

At Altas we use the results. Over the past three years we have spent about $250,000 using insolation tapes to study the BEPS criteria, the performance of systems, and the adequacy of "TMY" tapes, and to debug the DOE-2 computer program. We have yet to come across a tape that can be used as is. Virtually all of them need to have gaps filled or fields of erroneous numbers corrected before they can be used. The end results are clearly as slovenly as the performance of the measurements.

When considering how this area has been botched by the Department of Energy and the National Oceanic and Atmospheric Administration, it is instructive to compare their work with that in nations where conscientious insolation measurement programs have been under way for years. Mexico has had a solid program since around 1910. In Chile, Argentina, and India, there have been good programs for decades. God help the technician in one of those countries who refused to clean bird droppings off the instruments! It is ironic that this nation, in which Ericsson, Langley, and Abbot developed so much of the instrumentation for insolation measurement, should exhibit such clownish behavior when good results finally become essential. ○

Francis de Winter, newly elected chairman of the American Section of the International Solar Energy Society, is president of Altas Corporation, Santa Cruz, Calif.

NATIONAL INFORMATION RESOURCE CENTER

As you can see from my critique of the BERP, many of the projects for which funding is being requested have already been accomplished in one form or another. This is not as much a criticism of the BERP as of the of availability of all types of information relating to building technology. As an active member of the Research and Technical Committee of ASHRAE, I review many requests for funding various types of reserch projects. It is interesting that a high percentage of the proposals from Academia and some from private research laboratories do not reference all the existing information available on the subject. This results in needless expenditures of funds and efforts.

I have also worked extensively in Europe and Russia and marveled at the various information retrieval systems in these countries, particularly through their various research institutes and building organizations.

In the USA, we have excellent information retrieval in the medical circles, in the chemical industry and the Erich system used in education, but there is no such system or capability for construction technology. Quantities of early research documents from our own Bureau of Standards are "out of print" or unobtainable. Some of these reports only go back 25 years.

I recommend a Building Information Technology Resource Center be established at the National Building Museum housed in the historic Pension Building. This is a non-profit organization established by Congress only a few years ago. In the original legislation, this National Building Museum was to set up a resource information center for the building community, but funding was not granted for this purpose. This center would collect reports, publications and all printed information related to building technology, first from all USA sources, then from Canadian sources, followed by Scandanavian Countries and then all other areas in Europe, South Africa, Australia, and New Zealand. We must not lose sight of the great amounts of European building research as they rebuilt from World War II and their concern for energy conservation, even 30 years ago. In the late 1950's, Sweden spent 5% of their GNP to import fuels.

This information Resource Center would catalogue all information and provide a cross reference and abstract service that could supply information in many forms and formats. This project for the '80's would allow researchers to quickly become knowledgeable on many building technology subjects. It would also reduce the amount of funds being expended in redevelopment research and serve as an education center for the construction industry.

Once in operation maybe 8 to 10 years, this Information Resource Center could be self sustaining by selling reprints, abstracts, and books on specialized subjects. When fully in operation, such a resource center could serve well and would be utilized.

I recommend initial funding by Congress to carry out the mandate of the original legislation.

SOLAR PROGRAMS

Regarding active and passive solar systems and applications, the DOE and its predecessor have contributed much valuable knowledge about solar heating and cooling of buildings. DOE has served as an interface between the public and private sectors in this activity and provided funding for:

- demonstration of systems and components
- monitoring of system performance
- hardware development
- acceleration of standards and codes
- conferences for information dissemination
- support of tax incentives
- preparation of manuals related to solar
- SERI and regional solar center projects

Now that a broad technological base has been established for solar's use in buildings, it is recommended that DOE's role be limited to certain specific programs:

1) An orderly phase-out of technology development, and tests of demonstration installations.

   The demonstration projects in federal buildings, the major Passive Solar Commercial Building Project being managed by the Chicago Office of DOE, and many regional residential projects presently in operation should be continued.

   No new verification or demonstration projects should be undertaken by DOE. It is recommended that minimum funding be maintained to continue monitoring some projects to determine successes, problems, and solutions so that the industry can learn from the extended operation of these systems.

2) The documentation of research and technical results of past and existing systems should be assimilated and disseminated to the industry.

   It is felt that a technical evaluation group should analyze the data that is being developed from these demonstration projects and that the results be published in a useful form for implementation. An effective method of dissemination of the research results is through technical papers and professional society publications. These papers and publications should be sent to the Information Resource Center at the National Building Museum for ready retrieval (note: see section on Information Resource Center)

3) DOE should support high-risk, long-range research with high potential benefits that has not been attempted by the industry.

Basically, the present research procedure for DOE is through the knowledge and capabilities of National Laboratories. Ideally though, any research undertaken should be a cooperative effort of both the public and private sectors so that practical contributions can be made by engineers, architects, system designers, and installers. These programs should be evaluated by a balanced technical evaluation team. This activity should receive minimal government support in FY 1984 because of the need to put into practice our current wealth of knowledge.

4) Coordination of research programs with other public sector agencies such as The Department of Commerce, The Department of Defense, and The Department of Agriculture.

A. The Department of Commerce, with The National Oceanic and Atmospheric Administration and The National Bureau of Standards under its jurisdiction should develop synergestic research programs that also meet building energy goals. The National Oceanic and Atmospheric Administration's (NOAA) primary purpose now is weather forecasting. Let me assure you that historical weather data is also of extreme importance to architects, engineers, contractors, building owners, code officials and others involved in designing and building energy efficient buildings.

B. The National Bureau of Standards is involved in many programs related to effective energy utilization in buildings. The bureau has many visiting committees and review panels and has exhibited excellent cooperation between the public and private sectors. Many of their programs are dealing with basic research, thus continuity of funding is necessary for maximizing the use of the facilities and manpower resources at NBS. While minimum funding has been made available to test and evaluate many types of buildings of different constructions, the funding for the use of the new Calibrated Hot Box is in question. This is a project that will not and probably cannot be performed by the private sector for technical, legal, and business reasons.

C. The Department of Defense has three major research facilities: Port Hulanne, California, Corps of Engineers; Research Laboratories at Urbana, Illinois, and the Cold Regions Research Laboratories, Hanover, New Hampshire. The programs of these facilities need to be integrated with the programs on energy and moisture at DOE.

D. The Department of Agriculture has the Forest Products Laboratories at Madison, Wisconsin. Because of their primary interest in utilization of wood structures, they are also doing work on thermal performances and the effects of moisture in total structures. They have a wealth of information that should be distributed to practicing professionals. Continuing support of projects on the thermal performance of wood framed structures is recommended.

FACILITIES FOR A FENESTRATION LABORATORY

There is a need to develop a new fenestration research and testing facility for measuring the total dynamic thermal performance of all types of full-scale three-dimension composite window construction. New low emissivity glasses, new types of films, new shading devices, new interior management systems, plus new technology in daylighting are demanding reliable technical information. Just as with the Calibrated Hot Box at the National Bureau of Standards, the diversity of these products and competitive business interests suggest that the federal government should fund such a facility. After several years of operation, such a facility should be self-supporting by designers, researchers, and manufacturers.

Today's buildings are using basic data on window heat transfer from the ASHRAE solar calorimeter that was constructed over 35 years ago and used throughout the 1950's. When ASHRAE closed the Cleveland research facility, the equipment was transferred to the University of Florida. In the intervening 35 years, economic and social conditions have changed drastically. Thus, this basic facility can no longer adequately handle the requirements for studying the performance of composite window constructions and managed wall systems which are becoming very complex in their thermal and solar performance.

This new proposed laboratory is not to be confused with the present mobile window program at LBL. The LBL program is primarily directed to and limited to developing design tools for utilizing natural daylighting.

APPENDIX

SPECIFIC COMMENTS ON "RESEARCH NEEDS" LISTED IN THE BUILDING ENERGY RESEARCH PROGRAM

I will limit my comments as to their potential value to the conservation of energy and the need for government support.

RESIDENTIAL BUILDINGS - NEW

Thermal Load Dynamics — This project would have little impact on energy usage. Thermal dynamics is used by equipment designers and is not a function of building design. The sizing of equipment is based on a "design day" and operates at other than optimum conditions 90% of the year. This is the province of ARI and NEWAHA and not the Federal Government.

New Thermal Storage and Glazing Materials

This work has been going on for over 35 years to my knowledge and is continuing at universities sponsored by industry. We now need an invention, not more technical information on thermal storage systems.

On glazing materials, the manufacturing industry has more new technology then we can take advantage of. Please refer to my discussion under the subject of Fenestration Laboratory.

Building Environmental Quality

Please refer to the comments listed earlier re: Page 3, Paragraph 6.

Building Materials and Systems Control

These are unrelated subjects and both are continually researched by private industry. they should recieve no government funding.

Research leading to high efficiency appliances.
Research leading to high efficiency heating and cooling systems.

There is presently more technical information available than is currently being implemented. As the price of energy increases in the future and the life cycle cost pay out period is reduced, the industry owners and users will pay the higher first cost.

APPLIED RESEARCH

Collection of data on thermal behavior of occupied buildings.

For 50 years, the industry has collected such data, some of it through university programs as at the University of Illinois and Ohio State. More data would be of little added benefit.

Other government funded data gathering efforts, have produced massive amounts of unanalyzed data, a useless result. Even analyzed data is useful only on a micro-climatized scale where adjustments are made for socio-economic classes and buliding type.

Such research seems better left to industry which more rapidly zeroes-in on productive programs and analyze and use the results promptly.

Please refer back to my comments relative to Page 2, Paragraph 2.

Integration of solar systems with conventional heating and cooling systems.

Two different subjects are inherent in this proposal

Integration of solar with heating is well understood, and numerous installers are profitably applying solar heating to new and retrofit warm air systems without government help. (See Solar Engineering, Oct. 1981)

The problems and limitations of applying solar are understood. The problems come from the higher delivery temperatures required, and are not correctable by research, basic or applied with conventional systems.

There are new types of cooling systems utilizing solar that are in final development stages. They are based on old technology and will be introduced shortly to the market place.

Collection of cost and performance data on integrated systems in various climatic regions.

The project would not be cost effective. See my recommendations on the need for micro-climate weather data.

Assessment of the Impact of energy efficient buildings on the utility load managements.

The program is already being studied by Edison Electric Institute and Electric Power Research Institute and is already being funded indirectly by the government. Programs such as co-generation and Peak Power Management are currently being conducted.

Prototype development of thermal storage and building envelope materials and components, active and passive solar systems.

Active solar system research is not needed. Information is readily available in ARI Standard 130 based on ASHRAE Standards 93-77, 94-77, 95-80, and 96-80.

Passive solar application in residential is known, it is a matter of education of the builders. Please refer to Design of Insulated Buildings Tyler Stewart Rogers 1951. Other data is already published in the ASHRAE Handbook.

Technology Transfer and Information Dissemination

I fail to see the cost effective benefits of educating home builders at governmental expense. The trades and homebuilders themselves, after this present financial shakedown period — will include many new faces. This turnover has occurred throughout the six recessions since World War II. The industry should conduct its own training, qualification, and certification program.

RESIDENTIAL BUILDINGS — EXISTING

Basic Research

New retrofit materials.

Research in materials is being accomplished by manufacturers as rapidly as needs are perceived. This is a proper area for industry sponsored research, where needs are rapidly met. Government sponsored research seldom achieves practical results toward achieving objectives.

Cost-effective retrofit techniques to mitigate infiltration and conduction losses.

Much has been done by industry and through the Utility Survey Programs. However, there is great difficulty in achieving meaningful public acceptance. Modest research may be useful.

Applied Research

Collection of cost and performance data on buildings before and after retrofits.

Such information is usually published promptly in trade and technical journals which are widely distributed and read. Research in this area seems unneeded.

Prototype development of packaged retrofit systems.

This is a product development area which can better be handled by manufacturers and designers when real markets are identified.

Analysis of how relationships between building owners and renters affect energy decisions.

Is this research? How will any information be put to practical use? Studies have already shown the differences between separate and group metering, and between inclusions and separation of heating or air conditioning in rent. It is doubtful this study could be cost effective.

Technology Transfer and Information Dessemination.

For both items listed, it would seem that publication in existing journals and periodical is a much quicker and less costly method of transmitting technology costly method of transmitting technology than the development of manuals. Publications can be kept up to date. This area does not seem to be "research".

COMMERCIAL BUILDINGS - NEW

Basic Research

Much of the work listed is already being done. The technology is currently available for advanced lighting, HVAC systems and controls. New glazing materials are available. (please see my recommendation for a Fenestration Laboratory) Heat recovery systems are available from many entepreneurs. These manufacturers be consulted. Please refer to my comments re: Page 3, Paragraph 6.

Applied Research

The five items listed can be answered by existing knowledge or will be available from DOE's Passive Solar Commercial Buidings Program. This is a $21 million program in wich data is being collected on 23 buildings in 16 states across the country. This program has involved all sectors of the building community.

I recommend that the government continue funding this program so that DOE can analyze the technical data, the approaches taken and the lessons learned and create some meaningful Passive Solar Design tools.

COMMERCIAL BUILDINGS - EXISTING

It is true that the research in this area is similar to that to be used for new commercial buildings. The projects listed under "applied research monitoring" will have the same problem listed under comments on Page 2, Point 2, only worse. This is due to the fact that in most cases the construction of the existing building will not be known.

OWENS-CORNING FIBERGLAS CORPORATION FIBERGLAS TOWER, TOLEDO, OHIO 43659, (419) 248-8000

July 29, 1982

The Honorable Don Fuqua, Chairman
Committee on Science and Technology
U.S. House of Representatives
Suite 2321
Rayburn House Office Building
Washington, D.C. 20515

Dear Mr. Fuqua:

Thank you for the opportunity to testify at the hearing of the Energy Development and Applications Subcommittee on "Building Energy Research," on July 22, 1982. In reviewing my prepared statement upon my return, I found that the supporting documents on the implementations of the National Program Plan for the Thermal Performance of Building Envelope Systems and Materials had been omitted. I feel that the statement of cooperation on the formation of a "Central Coordinating Council" is relevant and important as it demonstrates cooperation between the public and private sectors.

I respectively request that the enclosed resolution, along with the roster be part of my prepared testimony.

I appreciate the opportunity of presenting this testimony for consideration by your Subcommittee.

Very truly yours,

Dan E. Morgenroth

Dan E. Morgenroth
Consultant

DER/cb
Enclosure

11-221 O—82——14

Appendix 1

May 19, 1982

STATEMENT OF COOPERATION

ON THE

FORMATION OF A CENTRAL COORDINATING COUNCIL

WHEREAS:

There is a continuing need for energy conservation in new and existing buildings for reasons of public health, economic hardship, national security, balance of payments, and building obsolescence, and

WHEREAS:

The building community is made up of thousands of small, medium and large businesses with diversified leadership on a national scale, and ownership of buildings is vested in tens of millions of people, and the building sector of the economy, as a whole, has not realized as much energy conservation expressed as a percentage reduction in the last five years as the transportation and industrial sectors, and

WHEREAS:

The potential for energy conservation in buildings is five- to ten-fold as great as has already been accomplished, on the average, and

WHEREAS:

The technology of energy conservation in buildings is extensive, it is by no means complete; existing and new building technology does not reach more than a small fraction of building designers, building contractors and owners because of inadequate dissemination and training

activities; correlation of technical information into manuals and handbooks of good practice is slow and incomplete; and the application of the consensus process to guidelines and standards for building practice are not sufficiently comprehensive, and

WHEREAS:

The public and private sectors of the building community have not had a mechanism to facilitate effective cooperation within existing organizations in the identification, execution and support of research and development programs, the timely development of guidelines, standard and building regulations, the clarification of industry and government roles and reconciliation of producer and user interests in the application of energy conservation technology.

BE IT RESOLVED THAT:

The representatives of the various organizations at this meeting believe that cooperative action between the public and private sectors of the building community is needed for future timely advancement of energy conservation in new and existing buildings, and that such cooperation offers the best promise of significantly broadening the inventory of energy-efficient buildings, which would accrue to the benefit of all of the citizens of the country.

The attendees at this meeting also endorse the formation of a Central Coordinating Council tentatively described in *The National Program Plan for the Thermal Performance of Building Envelope Systems and Materials*, ORNL/Sub-7973/1, operating under a secretariat. The Council would

promote and support a cooperative effort involving both public and private sectors; develop the technical base for the design, construction, and operation of buildings of cost-effective energy efficiency; and effect timely introduction of energy conserving technology into the building process.

The attendees endorse the establishment of an ad hoc committee to form the Central Coordinating Council, develop the role of the secretariat, and other action items identified at this meeting. The ad hoc committee would be directed to report its recommendations back to the attendees of this meeting. The attendees believe the National Institute of Building Sciences is an appropriate location of the secretariat but that the ad hoc committee shouldn't be restricted to this one alternative. The ad hoc committee is to be dissolved when the Central Coordinating Council has held its organizational meeting and the secretariat is functioning.

It is further stipulated that the individuals at this meeting, while cognizant of and influenced by the interests of the organizations they represent, are expressing their own professional judgments and are not expressing the official position of their organization in the opinions and positions voiced for or against the foregoing resolutions of the meeting.

APPENDIX II

AGENDA

IMPLEMENTATION OF THE NATIONAL PROGRAM PLAN
FOR THE
THERMAL PERFORMANCE OF BUILDING ENVELOPE SYSTEMS AND MATERIALS

Wednesday, May 19, 1982

9:30 AM

Offices of Steptoe and Johnson
5th Floor Conference Room
1250 Connecticut Avenue, N. W.
Washington, DC

John Millhone, presiding

1. Meeting Purpose (John Millhone)

2. Opening Remarks (Maxine Savitz)

3. Overview of the National Program Plan (Reece Achenbach)

4. Discussion and Questions

5. An Overview of the Proposed Thermal Envelope Coordinating Council (Gene Stamper)

   5.1 Need, Purpose, and Scope (Gene Stamper)
   - Discussion
   5.2 Thermal Envelope Coordinating Council - Its Secretariat and Its Role (Dan Morgenroth)
   - Discussion
   5.3 Building Community Representation on the Council and Membership Stature (Dan Morgenroth)
   - Discussion

6. Development and Approval of a Statement of Cooperation on the Council Concept (Reece Achenbach/Ted Lundy)

7. Establishment of an Ad Hoc Committee for Council Formation (John Millhone)

8. Action Items for the Ad Hoc Committee

   8.1 Workshop for Building Community Representatives
   8.2 Receipt and Evaluation of Proposal for the Secretariat
   8.3 Development of Purpose and Scope of the Council
   8.4 Financial Support of Council and Secretariat
   8.5 Time Schedules for Council Formation
   8.6 Selection of and Invitation to Council Members
   8.7 Planning and Scheduling Organizational Meeting of Council
   8.8 Termination of Ad Hoc Committee

IV. ATTENDANCE LIST
FOR THE MEETING ON
IMPLEMENTATION OF THE NATIONAL PROGRAM PLAN

Mr. Reece Achenback	Consultant to ORNL
Cmdr. Steve Beattie	USN, Manager Facilities Energy Program Department of Defense
Mr. Andrew Boggs	Executive V.P. ASHRAE
Mr. Jean Boulin	Program Manager D.O.E.
Mr. Gene Brewer	President National Institute of Building Sciences
Mr. David Bullen	A.I.A. Manager Energy Program
Mr. Millard Carr	Staff Engineer Energy & Utilities, Department of Defense
Dr. Jack Chaddock	President ASHRAE - Dean of Mechanical Engineering, Duke University
Mr. Wayne Ellis	Past President ASTM - H.B. Fuller Company
Mr. William Goodwin	Chairman of the Board ASTM
Mr. Jasper Hawkins	Chairman of the Board NIBS
Mr. Craig Hoellwarth	A.I.A. Research Foundation
Mr. Bob Holliday	Department of Energy
Mr. Charles Ince	President, A.I.A. Research Foundation
Mr. Paul Kando	NAHB Research Foundation
Mr. David Kluckhuhn	U.S. Department of Housing and Urban Development
Mr. Ted Lundy	Oak Ridge National Laboratories
Mr. Gardner McBride	Executive Director, Building Owners and Managers Int. Association
Mr. Preston McNall	Chief, Building Physics Division - National Bureau of Standards
Mr. John Millhone	Director, Office of Building Energy Research & Development, D.O.E.
Mr. Dan E. Morgenroth	Corporate Marketing Advisor - Owens-Corning Fiberglas
Mr. Roberty Oliver	Branch Chief - D.O.E.
Mr. David Pellish	Chief Materials & Technology, D.O.E.
Dr. Maxine Savitz	Deputy Assistant Secretary, D.O.E.
Mr. James Smith	Director Building Systems Division, D.O.E.
Mr. Milton Smithman	Staff Vice President, N.A.H.B.
Mr. Robert Spangler	Council of American Building Officals
Dr. Eugene Stamper	Dean Third College, Newark, N.J.

Mr. FUQUA. Thank you very much, Mr. Morgenroth.

Mr. McBride, has the present DOE conservation program paid adequate attention to commercial buildings and particularly the retrofit area?

Mr. MCBRIDE. It is very difficult to answer that question without answering it somewhat relatively. The answer is that the attention they have paid has been very useful in many instances.

Mr. FUQUA. Has it been enough?

Mr. MCBRIDE. To do what?

Mr. FUQUA. Do you think the commercial buildings—I do not know the percentage of energy that is used in commercial buildings, but I imagine it is rather high.

Mr. MCBRIDE. Yes. I think it is 13 percent or something like that.

Mr. FUQUA. Thus it is a very significant part of our energy consumption. My concern is, do you think they have paid adequate attention to it at DOE, or has it been inadequate?

Mr. MCBRIDE. If we are saying, has it been adequate to get the kind of savings that are available to be had, with confirmation that they are really there, the answer is no. If you are asking me about the way they have gone about it—have they done it effectively, has it been adequate in style—I would say yes, I think they have done a pretty good job.

Mr. FUQUA. Has what they have done been good?

Mr. MCBRIDE. What they have done has been good, and we actively pursue what they do and attempt to glean from it that which will be useful to the members of our association. I am in exactly the same position as a number of other people that are either in this room or I know personally, we are all trying to get what we can out of that research effort. We are all saying to ourselves, if this was really a little more serious research effort—not that they are not trying, but it is just a matter of the funding—then we could do a lot more.

Mr. FUQUA. You testified last year before our subcommittee about the need for product testing under field conditions for commercial buildings. Does that need still exist?

Mr. MCBRIDE. Oh, yes; it absolutely needs to exist. At this table alone we could have several hours of debate that I think you might find fascinating, as we talked about the various agendas that were presented to you here, just in the divergence of opinion among these three people.

You can imagine what the individual person who is building a building has to deal with, with conflicting advice and suggestions of what is really good, and what is not really good, and you should do all passive solar, and passive solar is not that important and what you should really pay attention to is your mechanical system. With all of that kind of advice, what the field person needs—the person who is actually at the point of spending a dollar—is some way to rate how effective a specific application is that he is considering and how it might integrate with the other kinds of applications that he is considering using.

Mr. FUQUA. Mr. Eberhard, the research agenda that you outlined is obviously a little more detailed and comprehensive than the building energy research program proposal, but are there any

major or significant differences, particularly in the philosophy—the way you approach it?

Mr. EBERHARD. I would suggest primarily in the one which I made facetious reference to earlier—namely, the proposed research agenda that was submitted from the National Academy of Sciences, begins with human requirements and human activities in buildings as the major driver of the requirement for research related to energy conservation. Otherwise, many of the things that were touched on within our report were also mentioned in the document presented to your committee.

Mr. FUQUA. Did you find any of the aspects of that program unacceptable or ill advised?

Mr. EBERHARD. I do not want to use the fifth amendment. I will have to answer that question again as an individual though, because I cannot express the Academy's opinion on that.

My personal judgment is—and I am surprised that Dan Morgenroth did not say more about it—there are a number of things in that proposal that I would think would be more appropriately undertaken by the private sector than by Federal funds.

Mr. MORGENROTH. It is in my written testimony report.

Mr. EBERHARD. When I first came to Washington in 1966 and worked within the Government at the National Bureau of Standards, I must say I was a great believer that somehow or other the private industry never got around to doing very innovative things, and it would be great if we could use Federal funds to get some innovations started, to develop prototypes, then have the private sector pick it up.

After some 18 years in the Washington scene, I must say that I am included amongst those who feel that excepting programs like the ones illustrated on these walls—NASA space program—and in military programs we are not very good within the Government at new product development.

Mr. FUQUA. Mr. Morgenroth, the book you referred to, the final version of the National Program Plan, appears to contain no specifics as to how the research is to be divided between the public and private sector in what the overall level of effort might be. Was this deliberate, or was it discussed in the finalization of the report? What exactly must be the Federal Government's and private sector's program of action to implement the plan?

Mr. MORGENROTH. The plan is actually a road map relative to a research agenda. It has listed in chapter 5 priorities of the many of the projects that need to be done.

The actual implementation, as far as funding is concerned, is strictly based upon the amount of research facilities and resources of professional people that can absorb the money that would be available to them.

Frankly, in both the public and the private sectors, in comparison with the amount of work that needs to be done, we would visualize that this National Program Plan is something like a 12- or a 15-year agenda. However, there are many of the projects that can be done in a relatively short period of time. Some of the projects are of such a magnitude that it will require a long period of time to complete.

Many of the people from the private sector have used this as a National Program Plan guiding plan for the expenditure of private research funds.

Mr. Chairman, I have here a computer printout of the long-range research agenda from ASHRAE. This agenda complements and integrates with the National Program Plan. Here are some 350 actual research projects that will be performed over a multiyear period of time. This agenda is planned to be done by the private sector.

The National Program Plan is not to be a dictatorial plan and is not divided as to what would be Government and what would be private. The National Program Plan recognizes all the diverse sectors and diverse needs of both the public and private sectors and their impact on the building process in the hope that we could encourage cooperative efforts between both the public and private sector and eliminate duplication.

The first draft of the NPP document, as was developed in 1978, indicated that if facilities were available, the research agenda would cost over $70 million and take over 10 years; and that was in 1979. So we feel that this is a long-term program and one, as was indicated by John Cable here earlier—one of the major objectives is to establish a level of research and have it on a continuing basis so we can maximize the use of our resources, our facilities, and manpower to the optimum.

Mr. FUQUA. Do you think DOE is taking the necessary steps to implement this plan?

Mr. MORGENROTH. At this time I feel that many of the projects that they have on their agenda complement the plan. This plan, from its original inception, has been in operation for about 4 years. There have been 14 areas—major areas—that have already been completed, and I feel, from what I know as of yesterday, DOE is considering supporting the Secretariat and the Coordinating Council and to set up an administrative group to see that this current program plan in this document is implemented, thus on a voluntary basis both the public and private sector will be working together.

Mr. FUQUA. You and Mr. Eberhard have mentioned that the private sector should support most of the research activity, not the Federal Government, yet we have had witnesses before us from the private sector that have testified that in the private sector they are too fragmented, they are undercapitalized to carry out such research. One of the previous witnesses, Ralph Johnson, discussed reasons why the homebuilding industry cannot carry out the needed research. Can you elaborate on that?

Mr. MORGENROTH. I know from the work that I am involved in at the present time, the ASHRAE group has a research agenda for using of private funds. On an annual basis we are expending about three-quarters of a million dollars. Due to the multiyear activities, we are spending over $1 million a year if private funds on energy research.

I feel that, as it had been stated, we do have a lot of small businesses that probably cannot fund research, but we have found that, due to the economic conditions, we can all band together and

should develop a larger funding resource—kitty—to do nonproprietary research.

I personally have been on a committee to raise funds for research, and I have found that when the building community was booming in 1977 and 1978 everybody wanted to do their own thing. In 1982 I have found great interest in people saying, "I can no longer afford my million dollars, or couple of million," or whatever it might be to carry on my own research. "Sure, I am willing to kick in $50,000 if you can get five other people to kick it in, and we will do a quarter-of-a-million-dollar project." This particular economic condition has brought about better cooperation for research and survival in the building community as far as the construction industry is concerned.

Mr. EBERHARD. Mr. Chairman, I prefer not to be misundertood. I do not see it as an either/or question: That is, either the private industry supports it, or the Federal Government supports it. The question is the nature of the research issue to be addressed. There are more than enough research issues that need to be addressed to use all that Congress is ever likely to appropriate in the present economic climate.

Some of the questions that are in this document which we received in the mail, such as basic research related to glazing materials, seems to me depend on the nature of what that project is going to be. If it is fundamental research that illuminates physics and the understanding of how you measure the properties of glazing materials, that appropriately is supported by Federal funds. If it is the actual experimenting with the possibility of glazing materials themselves and prototype development of new kinds of glass—I think you referred to your eyeglasses earlier as an example—then unless the private sector is doing that work in their own labs, there is not likely to be a product that ends up in the marketplace that people can buy and install in buildings.

Unfortunately, there is not a very successful history, other than in the space and weapons systems, of Government laboratories developing products that end up being commercial products in the marketplace.

Mr. MORGENROTH. Mr. Chairman, this is why I made in one of my recommendations Federal Government support of a fenestration-type laboratory, because our systems are becoming very complicated. Just as in a window system, it is no longer necessary to limit research to determine the thermal performance of the glass or its solar impacts. The utilization of low emissivity glasses, new films on glasses, new solar shading devices, the use of daylighting and interior fenestrations, and so forth, gets us into areas that might be considered constraint of trade if a couple of organizations got together and tried "to do their own thing". That is why I would suggest that the Federal Government sponsor the laboratory, which eventually could become self-supporting.

Mr. Chairman, this is not any different from that which the National Bureau of Standards did in the 1920; when Dr. Ingbuerg developed the first fire testing technique for determining the fire ratings of building systems and eventually these test procedures expanded into private laboratories, and is now a self-supporting activ-

ity in this country, but it was funded and started by the Federal Government to meet a need.

Mr. FUQUA. How would that differ, what you are proposing, from say, what is happening now at the Lawrence Berkeley lab with their window and daylighting program?

Mr. MORGENROTH. That is a mobile research facility as opposed to a stationary major resource center. It is primarily directed toward daylighting and its impact on passive solar design, as opposed to the overall standard reference base for publishing and testing many of the commercially available products for dissemination of uniform technical data to the industry for their utilization.

I just happen to have here a 12-page document from ASHRAE as to why it is different from the LBL laboratory. In fact, it happened to be prepared by one of the gentlemen from LBL as to what is really needed different from their own present facilities.

Mr. FUQUA. Thank you, gentlemen, very much for being here today. I apologize for taking so long to get through, but I think you can tell that this is a very important subject and one that, while there may be some divergence of views, does have a great deal of interest. I thank all of you very much for being here.

[Whereupon, at 12:40 p.m., the hearing was recessed.]

APPENDIX

STATEMENT FOR THE RECORD

ROBERT M. LAWRENCE, PRESIDENT
THE AMERICAN INSTITUTE OF ARCHITECTS

FOR THE HEARING OF JULY 22, 1982
BEFORE THE
SUBCOMMITTEE ON ENERGY DEVELOPMENT AND APPLICATIONS
HOUSE COMMITTEE ON SCIENCE AND TECHNOLOGY
WASHINGTON, D. C.

THE AMERICAN INSTITUTE OF ARCHITECTS
1857 • 1982 The First 125 Years

September 3, 1982

The Honorable Don Fuqua, Chairman
Subcommittee on Energy Development and Applications
B374 Rayburn House Office Building
Washington, DC 20515

Dear Chairman Fuqua:

Although we did not testify on the hearing on the Building Energy Research Program, The American Institute of Architects is requesting that our written comments on the BERP proposal be included in the July 22, 1982 hearing record.

On behalf of the American Institute of Architects, I would like to express our appreciation for holding a hearing on the Building Energy Research Program. The hearing provided a valuable opportunity to hear the opinions of researchers at the national laboratories and other representatives of the building industry on the merits of the Building Energy Research Program.

Thank you for the opportunity to present our comments.

Sincerely,

Robert M. Lawrence

Robert M. Lawrence, FAIA
President

Enclosure

1735 New York Avenue, N.W., Washington, D.C. 20006 (202) 626-7300

THE BUILDING ENERGY RESEARCH PROGRAM: THE AIA'S PERSPECTIVE

Introduction

The Building Energy Research Program (BERP) is a proposal to organize federally-sponsored research on energy use in buildings in a manner that recognizes that buildings are energy using systems. The BERP proposal calls for a balanced federal buildings research program; one that gives proper emphasis to basic research, applied research and technology transfer activities. The BERP proposal also sets forth the basis for a public-private partnership by which the energy efficiency of the nation's building stock can be increased by defining the ways the federal government can augment the private sector's efforts to design and construct more energy efficient buildings.

An Integrated Program

The AIA is committed to the integrated nature of the BERP proposal because the most dramatic reductions in energy usage occur when building designers use conservation and passive solutions in an integrated fashion. In order to achieve these savings, the building industry needs to know what are the most effective combinations of passive and conservation techniques for different building types in various climate regions. For years, the Department of Energy (DOE) conservation and solar programs have operated independently and in isolation from each other. Consequently, the building industry has made less progress in producing energy efficient buildings than if the DOE had produced the needed answers by coordinating the research activities of these two programs.

As one of the major developers of the BERP proposal, the AIA is concerned with how BERP may fit into the DOE organization. We do not wish to see BERP housed in the conservation program. Historically, the conservation program has emphasized the development of individual energy technologies and materials with little thought as to how they are integrated into large-scale buildings or if they will be utilized by the building industry. Except for the BEPS regulatory program, the DOE conservation programs have never focused on building design as a means to bring about an overall reduction in buildings' energy use. In contrast, the DOE passive program has focused on how to combine elements of passive design so that the sun's energy can be utilized as part of the building's overall design. To the AIA, difference in these two DOE programs is dramatic and represents two basic different philosophical approaches for the design profession.

Technology Transfer

Technology transfer is a major component of the BERP proposal. It was included because large amounts of existing DOE

research have never been successfully disseminated to or understood by the building industry. For example, many research reports are not well understood except by the researchers who were intimately involved in their development because they are built on layers and layers of undisclosed assumptions. Traditionally, most DOE researchers hve not welcomed private sector inquiries into their research methodologies or their conclusions. This means that the private sector must exert considerable effort to understand DOE's research conclusions. Unfortunately, DOE has no established method for assuring that the results of its research programs become known to the private sector. Fragmented dissemination activities are occurring, but not in a systematic way. In rare cases, DOE has come to the AIA for a review of the final product before it is printed. But such occasions are the exception rather than the rule. While these activities are of some assistance to a limited number of AIA members, this approach does not insure that a large number of the AIA's members understand the government's findings.

In addition, most architects do not buy research reports from the Government Printing Office and the National Technical Information Services because they tend not to trust information that has been developed by the federal government. Furthermore, most practitioners will not use information if it is hidden in a thick research report. Building industry practitioners want energy information in formats that are compatible with existing practices, such as articles in trade and professional journals.

In spite of these criticisms, the AIA believes that DOE has a role to play in making the building industry aware of its accomplishments. We feel this is even more important now that a formal proposal for dismantling DOE has been made.

However, rather than relying on past methods, DOE should be encouraged to find new ways of insuring that the building industry has an opportunity to understand and utilize DOE research findings. For example, the AIA believes that DOE should look for opportunities to turn its data bases and research results over to the appropriate segments of the building industry for further analysis, dissemination, and archival purposes. Institutionalization of DOE's data by the research components of the major building industry associations will insure its availability to current and future researchers and members of their professional associations, especially if these programs are eliminated or substantially redirected.

We recognize that this approach is a dramatic shift from current DOE practices. But, we believe now is an appropriate time to consider such an idea. First, the AIA and other associations are capable of assimilating this data into their energy information systems. Secondly, the directions of these programs are changing substantially from an applied approach to a more basic research approach, which could mean that much of the

existing data will never be transfered to the building industry.

Research Priorities

The Building Energy Research Program was developed by the primary representatives of the building industry and several energy public interest groups. Its authors never presupposed that the BERP research agenda would be final or all inclusive. Rather, it was developed to focus on what the federal government should be doing to augment the private sector's efforts. The developing organizations always intended that the specific research agenda would be developed by directly consulting with the energy leaders of the building industry as well as with the leading private and public sector researchers and the Department of Energy. Like the AIA, every representative organization has its energy leaders who would be willing to contribute their practical experience and professional insights to the development of a more detailed list of research priorities.

Direct Consultation

As one of its main premises, the BERP calls for direct consultation with the building industry. The long-established representatives of the building industry required that this be a basic theme of the Building Energy Research Program because of their previous experience with the DOE conservation and solar programs. In our opinion, many of the program planners at DOE are out of touch with the practical realities of designing and constructing residential and commercial buildings. Consequently, quite a few of the DOE's research programs have produced results that have little practical applicability for the building industry.

The AIA believes that direct consultation is an appropriate method for establishing DOE research priorities because the building industry is much more experienced in these areas now than they were when federal energy research programs were begun in the mid 1970s. The building industry is very aware of its own research needs because our members encounter energy design problems when they attempt to find new energy solutions by using state-of-the-art design concepts and new technologies in their current design projects. In addition, the AIA Foundation is always turning up unanswered energy questions as they try to assimilate DOE research findings into the AIA "Energy in Architecture" program and the AIA's energy publication

Due in large part to the substantial contributions of the Department of Energy, the research priorities of each segment of the building industry have become much more fine-tuned. Furthermore, every segment of the building industry is able to clearly articulate the specific needs of its members. Consequently, deriving research priorities through a consensus process is unnecessary and inappropriate. Instead, each segment needs to be directly consulted by the Department of Energy.

Conclusion

The AIA believes that the Building Energy Research Program has considerable potential to bring about a more effective use of the remaining federal resources for building energy research. The BERP proposal sets forth a plan for mutual cooperation between the public and private sectors which, if implemented, would bring about a more rapid increase in integration of new energy-saving technologies and design concepts into the nation's building stock. However, the integration of existing programs must be carefully considered so that the building-industry partnership can be developed in an effective manner.